Talgo

Antonio Perez
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1000 Second Ave., Suite 1950
Seattle, WA 98104

October 29, 2019

Via E-mail to correspondence@ntsb.gov

The Honorable Robert L. Sumwalt
Chairman, National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington DC 20594

Re: Talgo, Inc. Petition for Reconsideration of National Transportation Safety Board Investigation No. RRD18MR001, Accident Report NTSB/RAR-19/01

Dear Chairman Sumwalt:

In accordance with 49 C.F.R. § 845.32, Talgo, Inc. petitions the National Transportation Safety Board to reconsider several of its findings and safety recommendations and its statement of the probable cause of the injuries and fatalities sustained in the high-speed derailment of Amtrak train 501 near DuPont, Washington, on December 18, 2017.

Talgo also requests an opportunity to meet with the NTSB Board Members and the NTSB investigators considering this Petition to assist in their understanding of the information contained herein.

Sincerely,

[redacted]

Antonio Perez
President and CEO, Talgo, Inc.

Attachments:
(1) Certificate of Service
(2) Talgo, Inc. Petition for Reconsideration

cc: The Honorable Bruce Landsberg, Vice Chairman, National Transportation Safety Board
The Honorable Jennifer Homendy, Member, National Transportation Safety Board
Michael Hiller, Investigator-in-Charge, National Transportation Safety Board Investigation No. RRD18MR001
Kathleen Silbaugh, General Counsel, National Transportation Safety Board
Scott Barrett, Party Coordinator, Federal Railroad Administration
Kathy Hunter, Party Coordinator, Washington Utilities and Transportation Commission
Ron Pate, Party Coordinator, Washington State Department of Transportation
Martin Young, Party Coordinator, Sound Transit (Central Puget Sound Transit Regional Transit Authority)
Timothy Tenne, Party Coordinator, Amtrak
Scott Palmer, Party Coordinator, Brotherhood of Locomotive Engineers and Trainmen
Herb Krohn, Party Coordinator, International Association of Sheet Metal, Air, Rail, and Transportation Workers
Shawn McCuaig & Paul Aichholzer, Party Coordinators, Siemens Industry, Inc.
Gary Halbert, Partner, Holland & Knight LLP

CERTIFICATE OF SERVICE

I hereby certify that on October 29, 2019, I caused to be served Talgo, Inc.'s Petition for Reconsideration of NTSB Investigation No. RRD18MR001 (DuPont, Washington—December 18, 2017) on the following:

Scott Barrett
Party Coordinator
Federal Railroad Administration

Timothy Tenne
Party Coordinator
Amtrak

Kathy Hunter
Party Coordinator
Washington Utilities and Transportation Commission

Scott Palmer
Party Coordinator
Brotherhood of Locomotive Engineers and Trainmen

Ron Pate
Party Coordinator
Washington State Department of Transportation

Herb Krohn
Party Coordinator
International Association of Sheet Metal, Air, Rail, & Transportation Workers

Martin Young
Party Coordinator
Sound Transit (Central Puget Sound Transit Regional Transit Authority)

Shawn McCuaig & Paul Aichholzer
Party Coordinators
Siemens Industry, Inc.

[redacted]

Antonio Perez
President and CEO, Talgo, Inc.

NATIONAL TRANSPORTATION SAFETY BOARD

INVESTIGATION NO. RRD18MR001

(DUPONT, WASHINGTON—DECEMBER 18, 2017)

Talgo, Inc.'s
Petition for Reconsideration of
NTSB Investigation No. RRD18MR001

October 29, 2019

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I. Introduction

On the morning of December 18, 2017, Amtrak passenger train 501 derailed from a highway overpass on the Pacific Northwest Rail Corridor because it entered a 30 mph curve traveling 78 mph. The lead locomotive and seven of the ten passenger railcars traveled down an embankment or off the overpass into the highway below, resulting in three fatalities and injuries to 65 passengers and highway travelers. In the ensuing civil litigation, Amtrak has conceded negligence for the excess speed at which the train was traveling, and assumed liability for compensatory damages proximately caused by the derailment.[1] Other factors allegedly contributing to the train's failure to slow to an appropriate speed include lack of a positive train control system, inadequate employee training on the route and equipment, and other ineffective environmental mitigations for the hazardous curve.[2]

The National Transportation Safety Board ("NTSB") conducted a sixteen-month investigation into the Amtrak train 501 derailment, and on May 21, 2019, adopted and issued its final accident report. Although the NTSB found that the factors listed above caused the derailment, it assigned causation for passenger ejections, injuries, and fatalities sustained during the accident squarely on the shoulders of the passenger railcar manufacturer, Talgo, Inc.[3] It also made several adverse findings about the current safety status and crashworthiness of the Series VI railcars at issue.[4] And, in an entirely unprecedented move, instead of recommending improvements or modifications to or further research on the Talgo railcars, the NTSB recommended that Talgo's transit partner discontinue use of Talgo's trainset entirely.[5]

As set forth herein, the NTSB investigation and final accident report that followed are replete with injustices toward Talgo and errors regarding its Series VI railcars and their role in the derailment. First, from a procedural standpoint, the NTSB deprived Talgo of a full and fair opportunity to participate in the investigation and explain and defend its design to the NTSB. Investigation No. RRD18MR001 marked the first time in history that the NTSB has considered the design and behavior of Talgo equipment. Yet Talgo was one of only two groups involved in

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[1] *See, e.g.*, ECF No. 13, Nat'l R.R. Passenger Corp., d/b/a Amtrak, Answer, Affirmative Defenses, and Jury Demand, at ¶¶ 3.5, 5.1, *Wimotte et al. v. Nat'l R.R. Passenger Corp.*, No. 2:18-cv-86 (filed Feb. 26, 2018); Or. Pub. Broadcasting, *Amtrak Concedes Negligence in Catastrophic Derailment South of Tacoma* (Sept. 2, 2019), *available at* https://www.opb.org/news/article/amtrak-cascades-derailment-trial-negligence/.

[2] *See* NTSB/RAR-19/01, *Amtrak Passenger Train 501 Derailment, DuPont, WA*, at 120-121, Findings 5, 7, 10, 19, 24 (May 21, 2019), *available at* https://www.ntsb.gov/investigations/AccidentReports/Pages/RAR1901.aspx.

[3] *Id.* at 122, Findings 30-31; *id.* at 124, Probable Cause. Talgo is the US-based subsidiary of Patentes Talgo S.L., a Spanish manufacturer of railway rolling stock. Talgo's Series VI trainset was designed in Spain and manufactured and maintained primarily in the U.S. The railcar bodies of the Series VI trainset are made of aluminum, whereas conventional U.S.-designed railcar bodies are primarily made of steel.

[4] *See* NTSB/RAR-19/01, at 122-23, Findings 34-37.

[5] *Id.* at 126, Recommendation to the Washington State Department of Transportation.

the investigation that were excluded as parties to the public investigative hearing on the Amtrak train 501 derailment, depriving Talgo of the opportunity to present evidence and testimony at the hearing on its railcars' design and crashworthiness. Throughout the course of the investigation the NTSB also declined four requests by Talgo to meet with staff and/or Board Members to share technical expertise and answer questions relating to its railcars' design or role in the derailment. And although Talgo provided a Party Submission on April 12, 2019 that outlined the performance of the Talgo cars, the NTSB staff did not mention (much less confront) this evidence in the final report, and staff failed to share Talgo's Party Submission with the NTSB Members in time for them to review it before the May 21, 2019 vote to adopt the final report. These procedural failings prevented the NTSB from obtaining a full and accurate understanding of the Talgo Series VI equipment, which resulted in the numerous errors appearing in the NTSB's final accident report.

Second, most of the NTSB's factual findings regarding the Talgo railcars are erroneous and contradicted both by evidence already contained on the investigation docket and by new finite element stress and collision dynamics analyses performed this summer by independent engineering firm Simpson, Gumpertz & Heger (Appendix A, the "SGH Report"). Together, this evidence establishes that the Talgo Series VI railcars meet the relevant federal safety standards and performed in the derailment as well as or better than conventional cars would have under similar circumstances. The Series VI trainset complies both with current regulations applicable to that equipment, and also with the newest requirements applicable to newly manufactured equipment, which were published eleven months after the Amtrak train 501 derailment. Particularly erroneous and misleading are the NTSB findings that relate to the Series VI trainsets' alleged structural vulnerabilities, lack of crashworthiness, failure to meet current U.S. safety standards, and the role of the FRA grandfathering provision in the outcome of the Amtrak train 501 derailment.

Third, even if the NTSB's findings regarding the Series VI equipment were accurate, perhaps the biggest injustice worked upon Talgo is the NTSB's unwarranted and unprecedented decision to recommend outright removal of the Series VI trainsets from service. Nothing in the record supports a conclusion by NTSB that its findings about Talgo's railcars cannot be resolved by modifications and/or improvements to the design and maintenance of the Talgo Series VI railcars. Indeed, Talgo and SGH have been unable to identify any other train accident in which the NTSB proposed such extreme measures, even in cases where the NTSB found that other railcars were not compliant with FRA standards, directly caused passenger injuries and fatalities, or contained inadequate structural, crashworthiness, and occupant safety protections.

Together, these errors, inequities, and unduly harsh recommendations suggest prejudice by the NTSB against European-designed railcars, in favor of conventional U.S.-designed cars and a U.S.-centric view of railcar safety design. Such a bias poses risks to rail safety worldwide, and is inconsistent with the overarching mission of the NTSB to promote and prioritize passenger safety above all else. The NTSB investigation did not fairly evaluate Talgo's equipment, yet even under this misguided scrutiny, Talgo has demonstrated its Series VI trainsets comply with FRA structural safety standards, while boasting a design with greater resistance against derailment than conventional cars. Accordingly, and as authorized by 49 C.F.R. § 845.32(a), Talgo respectfully requests that the NTSB reconsider and modify several of its findings, probable cause statements, and safety recommendations concerning Talgo in Accident Report No. NTSB/RAR-19/01.

II. Overview of Amtrak Train 501 Investigation and Evidence

Immediately after the Amtrak train 501 derailment, the NTSB opened an accident investigation, NTSB Investigation No. RRD18MR001. For the next seventeen months, all parties involved in the investigation supported NTSB's efforts to identify and understand the causes of the accident and derive appropriate safety recommendations from those efforts. As a party to the investigation, Talgo was pleased to have the opportunity to support the NTSB and dedicated several employees to assist and to provide responses and information when requested. Over the course of the investigation, however, the NTSB failed to make use of Talgo's unique expertise on its own technologies and did not consider certain evidence presented by Talgo on the crashworthiness of the railcars involved in the derailment.

Following an initial period of fact gathering, the NTSB held an investigative hearing titled *Managing Safety on Passenger Railroads* on July 10-11, 2018, to examine and gather evidence on the Amtrak train 501 derailment and another Amtrak derailment in Cayce, South Carolina. According to a December 12, 2018 email from then Investigator-in-Charge Ted Turpin to Talgo President Antonio Perez, during the hearing, "the NTSB heard testimony from multiple stakeholders," and "the information gathered during the hearing allowed investigators to gain additional information regarding the accident" that investigators were analyzing.[6]

One important stakeholder from whom the NTSB gained no additional information at the investigative hearing was Talgo. In fact, the NTSB invited seven of the nine organizations designated as "parties" to the investigation to be "parties" to the investigative hearing[7]; only the manufacturer of the lead locomotive (Siemens Industry, Inc.) and the manufacturer of the passenger railcars (Talgo) were excluded. The parties to the hearing attended a pre-hearing conference to review topics that would be discussed, and at the hearing were permitted to provide evidence and testimony about their respective areas of expertise. After the hearing, several of the hearing parties, including Amtrak, FRA, Sound Transit, and the Washington State Department of Transportation, made post-hearing submissions to the NTSB.[8]

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[6] *See* 12/13/2018 Investigation Status at www.ntsb.gov/investigations/Pages/RRD18MR001.aspx.

[7] According to NTSB regulations, the NTSB designates as parties to an investigative hearing, "those persons and organizations whose participation in the hearing is deemed necessary in the public interest and whose special knowledge will contribute to the development of pertinent evidence." 49 C.F.R. § 845.6; *see also* Hearing Exhibit 6, *Statement of the Purpose of a National Transportation Safety Board Investigative Hearing*, Docket ID DCA18HR001.

[8] *See* Dkt. DCA18HR001, Exhibit Group H, Exhibits 1-5. Parties to NTSB investigative hearings are permitted to "submit proposed findings to be drawn from the testimony and exhibits, a proposed probable cause, and proposed safety recommendations designed to prevent future accidents or incidents." 49 C.F.R. § 845.13.

It is unusual for the NTSB to conduct a hearing and not invite a party to the investigation to be a party to the hearing. This is especially true when the government's approval of and the crashworthiness of that party's equipment is a subject of discussion, as was the case with the Talgo Series VI railcars. At the time of the hearing, NTSB investigative staff published, as Hearing Exhibit 7, a Crashworthiness and Survival Factors Group Factual Report, which contained an extensive discussion of the Talgo Series VI trainsets. Also, included in the topics for discussion at the hearing was the "Grandfathered Approval of Rail Passenger Equipment," which was directed to the Federal Railroad Administration (FRA) approval of the Series VI trainsets. During the proceedings, the crashworthiness of the Talgo railcars and the FRA's regulatory approval thereof was the subject of questioning by the NTSB technical panel, without any Talgo representative invited to contribute.[9]

After the hearing, one piece of evidence requested of Talgo was information regarding the retaining straps used to amplify the truck-to-carbody attachment strength of its Series VI railcars. Talgo provided the strap manufacturer's data sheets, which documented the strength of its retaining straps when used in a "basket" configuration, as was employed on Amtrak train 501. The NTSB's final accident report, however, cites laboratory testing that subjected the Talgo straps to a simple strap tension strength analysis. This testing protocol fails to account for the effect of the basket configuration on the load-bearing capabilities of the straps, and thus the NTSB strength test tested the straps in a manner that reduced the load-bearing capabilities of the straps by 50 percent. Talgo alerted the NTSB to this mistake in its testing, but the NTSB never revised its conclusions.[10]

On April 12, 2019, Talgo submitted its Party Submission (Dkt. RRD18MR001, No. 5), which contained proposed findings, proposed safety recommendations, and other helpful evidence relating to the derailment. For reasons unknown to Talgo, its Party Submission was not distributed to the NTSB Members in time for them to review Talgo's submission before the Members voted to adopt the final accident report. NTSB Members were not made aware of the Talgo Party Submission until just prior to the May 21, 2019 Board Meeting, by which time Board Member feedback had been received and the final internal draft of the accident report had already been completed. Talgo learned of this mishandling shortly after the Board Meeting, when one NTSB Member's Special Assistant informed Talgo that the Member had not had an opportunity to review Talgo's Party Submission. Talgo later received confirmation that no Member received the Talgo Party Submission in time to review it beforehand. As a result, the NTSB staff's proposed findings and conclusions regarding the Talgo cars were accepted without being tested against Talgo's evidence, because the NTSB Members had no idea that Talgo's Party Submission directly refuted the report prepared and presented by NTSB staff. The final accident report does not reference the Talgo Party Submission or confront and explain the disparities between Talgo's evidence and the NTSB's findings. In short, Talgo's Party Submission was not considered prior to the vote of the NTSB Members, and the NTSB's final report reflects an incomplete understanding of the facts regarding the accident and performance of the Talgo cars.

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[9] *See id.* Exhibit Group I, Exh. 1, *Transcript with Errata - Day One,* at 172-75.

[10] *See* Dkt. RRD18MR001, No. 33, *NTSB Safety Strap Information Request July 2018*.

In addition to these written submissions, in late 2018 and early 2019, Talgo offered on four separate occasions to meet in person with the Investigator-in-Charge or with NTSB Members to discuss its evidence and answer any questions the NTSB might have. *See* Appendix B. Talgo was concerned at that time because of comments by the IIC that evidenced a bias against Talgo's design and that the IIC and staff were drawing premature and unfounded conclusions about the performance of the Talgo railcars. *See* Appendix C, Declaration of Joshua D. Coran, ¶¶ 3-7. At every turn, the NTSB declined or disregarded Talgo's offers as unnecessary. It is Talgo's understanding that several other parties to the investigation were permitted to meet with the NTSB in the spring of 2019.

Along with the evidence already on record, the attached appendices provide additional new evidence of Talgo railcars' performance and their compliance with FRA crashworthiness standards. In the wake of the NTSB's issuance of the final accident report, Talgo asked a national engineering firm, Simpson Gumpertz & Heger ("SGH"), to conduct an independent engineering analysis of the crashworthiness of its Series VI railcars. SGH reviewed the design and conducted finite element stress and collision dynamics analyses and calculations on the Talgo Series VI railcars. Neither the NTSB docket for the investigative hearing DCA18HR001, nor the final accident docket, RRD18MR001, contain evidence of a thorough compliance or engineering finite element analysis of the overall Talgo Series VI trainsets, such as was conducted by SGH.

Also submitted in support of this petition is the letter to the NTSB from the FRA (Appendix D). In its response to NTSB Safety Recommendation R-19-012 (that the FRA remove the static end strength grandfathering provision under which Talgo Series VI trainsets were approved for operation), the FRA has taken the clear position that: "[I]n the Amtrak 501 derailment, the end structure supporting the Talgo Series 6 equipment showed no evidence of premature failure and proved to perform exceptionally well for such a high-energy event. FRA's observations from the accident site revealed that there was no loss of occupant volume due to end-frame compression." Like Talgo, who argues herein that the recommendation is not supported by the facts underpinning the investigation, the FRA requests that the NTSB close Safety Recommendation R-19-012 with no action taken by the FRA.

By failing to conduct thorough testing and inquiries, excluding Talgo as a party to the investigative hearing, ignoring written evidence Talgo submitted, and disregarding Talgo's multiple offers for in-person meetings, the NTSB deprived itself of critical evidence that undermines findings in its final accident report. The outcome of these procedural failings—a highly flawed final accident report—compels Talgo to submit this Petition for Reconsideration under 49 CFR § 845.32, which provides for reconsideration "based on the discovery of new evidence or on a showing that the Board's findings are erroneous." Talgo notified the NTSB of its intent to file this petition on June 3, 2019. *See* Appendix E.

III. Analysis

A. The NTSB's Final Accident Report Contains Findings and Conclusions Disproven by Facts Set Forth in Talgo's Party Submission.

The NTSB's final accident report contains findings and conclusions inconsistent with and controverted by the following points made in the Talgo Party Submission. As set forth above, the NTSB Members were deprived of the ability to consider these important inputs from Talgo by the inexplicable delay in staff providing access to the Talgo Party Submission. Had the Members reviewed this information, it could have been considered and formed the basis of questioning during the May 21, 2019 Board Meeting. The NTSB's final accident report does not mention or explain why it disregards and contradicts information set forth in Talgo's Party Submission.

1. The static end strength of the Talgo Series VI railcars was not a factor in the Amtrak train 501 derailment.

Several of the NTSB's findings, its probable cause statement, and its recommendation to FRA erroneously imply a connection between FRA's decision to "grandfather" one aspect of the Talgo trainset and the Amtrak train 501 derailment.[11] However, Talgo's Party Submission explains that the Series VI railcars' static end strength—the grandfathered aspect of its trainset—was not an issue in the Amtrak train 501 derailment. Static end strength is a requirement for protection of those onboard during a collision. As the NTSB acknowledged, the focus of the FRA regulatory approach was "to protect occupants from the loss of survivable space."[12] Static end strength was neither compromised, nor is it a relevant measure of the Talgo Series VI performance in the accident because the Amtrak train 501 derailment did not result in loss of occupant volume due to end-frame compression.

While there have been no collisions during the 25 years of modern Talgo operation in North America (nor any during Talgo operation in the late 1950s and early 1960s in New England and Illinois), the NTSB's concern with static end strength is understandable given the large number of collisions the NTSB has investigated. However, in assigning causation to the

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[11] *See* NTSB/RAR-19/01, Findings 35 ("The Talgo Series VI trainset designed as Amtrak train 501 was not in compliance with the terms and conditions of the [FRA]'s grandfathering agreement.") and 36 ("Allowing the grandfathering provision to remain in Tile 49 [CFR] 238.203(d) . . . is an unnecessary risk that is not in the public interest nor consistent with railroad safety."); *id.* at 124, Probable Cause ("Contributing to the severity of the accident was the [FRA]'s decision to permit railcars that did not meet regulatory strength requirements to be used in revenue passenger service, resulting in (1) the loss of survivable space and (2) the failed articulated railcar-to-railcar connections that enabled secondary collisions with the surrounding environment causing severe damage to railcar-body structures which then failed to provide occupant protection resulting in passenger ejections, injuries, and fatalities."); *id.* at 125, Safety Recommendation R-19-011 ("Remove the grandfathering provision within Title 49 [CFR] 338.206(d) and require all railcars comply with the applicable current safety standards.").

[12] NTSB/RAR-19/01 at 102.

Talgo cars, the NTSB has ignored the careful studies performed by recognized third-party industry experts at Arthur D. Little (a consulting firm) and the Volpe Center (the US DOT research & development organization) that concluded the Talgo Series VI trainset was at least as safe as conventional equipment in this regard. That conclusion was required by FRA before it would issue its "Final Decision" (dated March 27, 2009) permitting continued operation of the equipment. The "Conclusions and Agency Action" section of that decision begins (on page 24) by saying, "Subject to the conditions set forth below, FRA concludes that sufficient information has been submitted to determine that the five Talgo trainsets can be operated consistent with railroad safety in the Pacific Northwest corridor at speeds up to 79 mph; or maximum speeds not to exceed 110 mph subject to conditions tied to review and approval of the train control system." While the NTSB spent seventeen months coming to its own internal conclusions, the FRA and its expert consultants dedicated ten years to evaluating Talgo safety. Talgo details this information in Section 2.2.4, pp. 21-22, and Section 2.3.2, pp. 25-31, of its Party Submission.

The FRA understands the standards and the scope of the grandfathering of the Talgo Series VI trainsets and it confirmed this point to the NTSB when it testified at the investigative hearing that "the actual grandfathering was for end frame compression," and that "the items that were covered in the grandfathering petition [for Talgo Series VI trainsets] performed adequately."[13] The FRA again reiterated this point in its recent response to NTSB Safety Recommendation R-19-012:

> The grandfathering provision under the Passenger Equipment Safety Standards, 49 CFR Part 238, concerns compliance with requirements for Static End Strength, as prescribed in 49 CFR § 238.203. . . . .
>
> In the Amtrak 501 derailment, the end structure supporting the Talgo Series 6 equipment showed no evidence of premature failure and proved to perform exceptionally well for such a high energy event. FRA's observations from the accident site revealed that there was *no loss of occupant volume due to end-frame compression*. Because the grandfathering provision concerns end-frame compression strength and this strength for the Talgo Series 6 trainsets was not a factor in the Amtrak 501 derailment, FRA does not believe it appropriate to remove the grandfathering provision on the basis of this accident, or any other basis.

Appendix D, Letter from The Honorable Ronald Batory, FRA Administrator, to The Honorable Robert L. Sumwalt III, NTSB Chairman, at 6 (September 27, 2019) (emphasis added). To be very clear: ***the requirement grandfathered was the structural strength, or end-frame compression, of the railcars, which remained without deformation during the Amtrak train 501 derailment***. No other aspects of the Talgo Series VI trainset required "grandfathering" to meet federal passenger equipment safety standards. The NTSB has thus misunderstood the scope and applicability of the grandfathering provision. NTSB investigators confused or misled the Board when they associated the grandfathering of one element of the design with the

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[13] Dkt. DCA18HR001, Grp. I, Exh. 2, *Managing Safety on Passenger Railroads Hearing Transcript with Errata – Day Two*, at 174:15-23.

fatalities and injuries of the accident, because the grandfathered element behaved in all respects as required and intended by the FRA.

2. The Talgo truck-to-carbody attachment strength was in compliance with federal regulations at the time of the derailment, and can be modified to provide twice the FRA-required strength.

The final accident report also pins several of its findings on the failure of the Talgo Series VI safety straps to comply with applicable safety standards.[14] In accordance with the FRA's Final Decision of 2009, Talgo incorporated additional truck (a.k.a. "rolling assembly") securement into the design of the Series VI trainsets to be used in the US. One aspect of this additional securement consisted of six nylon straps per truck. While the NTSB reports that it found intact straps in the wreckage and "exemplar" straps from another Talgo trainset to have deteriorated over time, even under an assumption that those straps attaching the trucks that became detached in the accident had deteriorated equally to those tested, Talgo's Party Submission explains that there would still have been sufficient attachment strength to meet the FRA requirement of 250,000 lb.

Talgo also has explained to the NTSB why its testing on the deteriorated straps (Materials Laboratory Factual Report 18-042) was deficient, as the tests did not replicate the "basket" configuration of the retaining straps that was employed on the Amtrak train 501 trainset. In 2018, Talgo provided the NTSB with testing results that documented the strength of its retaining straps when used in a basket configuration. The NTSB, however, relies upon laboratory strength testing that subjected the Talgo straps to a simple strap tension strength: a configuration that reduces the load-bearing capabilities of the straps by 50 percent. Talgo alerted the NTSB to this mistake in its testing protocol, but the lead investigator either was not convinced of the errors in the NTSB's testing methodology or simply decided not to correct it.

Even if the remaining attachment strength had not been sufficient at the time of the accident, there are three compelling reasons why it is illogical to use this condition as a basis to recommend retirement of the entire Talgo Series VI fleet. First, the condition of retaining straps is a maintenance issue, not a design issue. When, for example, a derailment is caused by a high flange that a daily inspection should have, but failed to, catch and correct, that derailment would not provide a reason to remove from service all equipment using a flanged wheel (*i.e.* all railroad vehicles). Second, Talgo corrected the problem of potentially deteriorated straps long before the

[14] *See* NTSB/RAR-19/01, Findings 32 ("The safety straps used for the Talgo Series VI trainset rolling assembly retention modifications were degraded due to their use in the exposed outdoor conditions and were used far past their service life."), 33 ("During the grandfathering approval process, the [FRA] failed to consider the limited useful life of the polyester straps used for the Talgo Series VI trainset used for the Talgo Series VI trainset rolling assembly retention modifications which had degraded and failed to improve the crashworthiness of the train."), 35 ("The Talgo Series VI trainset designed as Amtrak train 501 was not in compliance with the terms and conditions of the [FRA]'s grandfathering agreement."), and 37 ("The Talgo Series VI trainset does not meet current United States safety standards and poses unnecessary risk to railroad passenger safety when involved in a derailment or collision.").

NTSB issued its final accident report. All four remaining Series VI train sets were immediately equipped with new straps. The condition of these straps has been closely monitored, and they will now be replaced on a periodic basis, regardless of apparent condition. Third, Talgo proposed (in Section 5.2 of its Party Submission) an even more robust attachment system patterned after that employed on the Talgo Series 8 trainset, which the FRA agrees is a fully compliant design.[15] The additional attachments provide retention strength of 500 kip, *two times* the FRA requirement. A logical recommendation from the NTSB related to truck attachment would take into account these revised maintenance practices and attachment configuration. This is explained and analyzed in Section 2.4.2, pp. 32-34, and Section 5.2, p. 63, of Talgo's Party Submission.

3. The low center of gravity of Talgo's railcars provides evidence that the lead locomotive was at least a contributing cause of the accident.

Talgo also explained that the Siemens lead locomotive was, at the very least, a "contributing cause" of the accident. The lead locomotive was the first vehicle to derail, and it dragged the Talgo railcars, which otherwise would have stayed on the track, with it. The centrifugal forces caused as a train travels through a curve tend to unload the wheels on the inside of the curve. The amount of unloading depends on the speed of travel and the height of the railcar's center of gravity. The speed required to unload the wheels to the point of derailment is significantly higher for the Talgo Series VI cars than for locomotives, including the Siemens locomotive, and conventionally designed passenger cars because the Talgo Series VI cars have a lower center of gravity. Since centrifugal force acts on the center of gravity, the lower the center of gravity, the less likely it is that the vehicle will derail.

Moreover, when a train runs through a curve at a speed greater than that for which it is super-elevated ("banked" in highway terms), centrifugal force will cause the wheels on the high rail (the one on the outside of the curve) to become more heavily loaded while those on the low rail will unload. If those inside wheels unload completely, the vehicle will be balanced on the high rail and thus be on the verge of overturning. The FRA limits this unloading to a maximum of 40% (49 CFR § 213.57); any more unloading is considered unsafe. To allow a higher speed in a given curve, the super-elevation can be increased; but, in order that a train can stop in a curve without the danger of high-center-of-gravity cars tipping over to the inside, the maximum super-elevation on track shared with freight trains is rarely as much as six inches and usually limited to five. If a train runs through a curve with five inches of super-elevation at a speed requiring six inches to keep wheel loading unchanged, it is said to be running at (6 - 5 = 1) one inch of "cant deficiency". Talgo equipment is designed to run safely at 7.2 inches of cant deficiency. The specification to which the Siemens locomotive was built[16] requires it to be suitable only for five inches of cant deficiency.

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[15] *See* R. Lauby, FRA, letter to N. Davies (July 31, 2013) (approving Talgo Series 8 trainsets entering passenger service "without specific restrictions"), *available upon request*.

[16] Diesel-Electric Locomotive specification written by the PRIIA Section 305 Next Generation Equipment Committee, Doc. 305-005.

Talgo's analysis as to whether its railcars would have derailed absent the forces from the top-heavy lead locomotive, and the supporting calculations, are set forth at Section 2.2.1 of the Talgo Party Submission. These facts contravene the NTSB's finding that the "Talgo Series VI trainset . . . poses unnecessary risk to railroad passenger safety when involved in a derailment or collision."[17]

4. Car C3, Amtrak 7504, was extensively damaged by impacting the end of the bridge while moving sideways, a completely different cause than that identified by the NTSB.

Finally, the NTSB claims the damage to Amtrak C3 7504, the first car that did not follow the locomotive into the woods, was caused by the rolling assembly from Car C6 (Amtrak 7422), three cars behind it (107 ft. 9 in. behind its center), catching up to it and striking Amtrak 7504 on the side that was facing forward, away from the direction from which that truck would have come.[18] The NTSB final accident report contends that "the side wall of the railcar was breached by the rolling assembly belonging to AMTK 7422 (10)."[19] That the rolling assembly did end up partially inside Amtrak C3 7504 is undisputed, but it clearly did so after the side was split open by impact with the bridge and the car had turned another 90 degrees after that impact so as to end up parallel to the track. As Talgo's Party Submission explains, the following derailment sequence is supported by the evidence of damage to C3 7504:

- The first five cars (power car 7903 through bistro 7303) caused C3 7504 to decelerate.
- C4 7424 and the cars behind it, still on the track, kept pushing C3 7504.
- With the front cars (following the locomotive) applying retarding force and the inertia of the rear cars, (still on the track) pushing, car C3 7504 started to rotate, breaking all the attachments between it and the adjacent cars and their shared trucks. . .
- At this time, due to this rotation the car was moving sideways, hitting the concrete wall on its left side.

[17] NTSB/RAR-19/01, Finding 37.

[18] *See* NTSB/RAR-19/01, Finding 31 ("The failure of the articulated connections of both Talgo Series VI passenger railcars AMTK 7422 (10) and AMTK 7504 (7), the detached rolling assembly from AMTK 7422 (10) and its secondary collision with AMTK 7504 (7) directly resulted in three fatalities and two partially ejected passengers who had been traveling in AMTK 7504 (7).").

[19] NTSB/RAR-19/01 at 53.

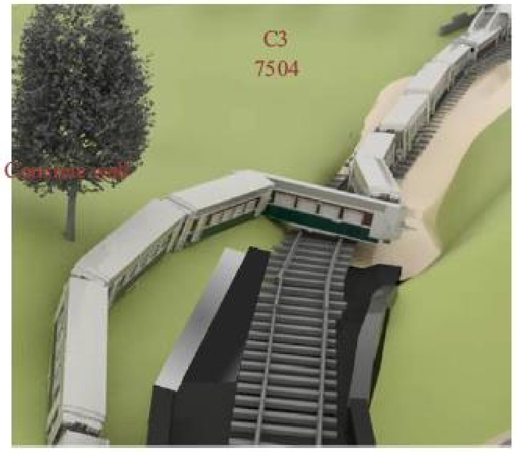

Figure 79 C3 7504. Moment prior to impact

- After the impact against the concrete wall, C3 7504 came to rest on top of C2 7554 and dining car 7804. The truck that belonged to C6 7422, three cars to the rear, was found under and next to C3. Part of the concrete wall was also found there. . . .

  As can be clearly seen in Figure 82 through 85 of Talgo's Party Submission, the damage to C3 7504 was produced by an impact with a large rigid body at high speed. The damage was extensive and clearly the result of the collision with the overpass retaining wall.[20]

Figure 82 C3 C7504 damage, left side

Analysis of the derailment sequence, the final positions of the railcars, and the physical evidence of damage to Amtrak C3 7504 support Talgo's conclusion that the breach of C3 7504's sidewall was from the violent impact with bridge, which tore open the car, and that the rolling assembly from Amtrak C6 7422 only ended up partially in C3 7504 after the bridge damage had occurred.

[20] Talgo Submission § 2.5.1. Fig. 79 & Fig. 82 at 47–49.

B. New evidence contained in the SGH Report substantiates the fact that the NTSB made erroneous findings about the damage to and crashworthiness of the Talgo Series VI trainsets.

The design of the Talgo Series VI trainsets was and remains in full compliance with applicable FRA requirements and was thus considered safe and fully suitable for service by both the operator and the FRA.[21] Like all other railroad equipment in the United States, the Series VI had not been modified to comply with new regulations applicable to new equipment built after it had been placed in service.[22] This sort of retrofit is never required by the FRA, which is the agency whose role is to ensure of the safety of rail equipment running in the US. It is therefore illogical for NTSB to find that the Series VI trainsets "pose unnecessary risk to railroad passenger safety" based largely on whether or not they satisfy federal safety standards with which the trainsets are not required to comply.

Despite the improper standard to which NTSB is holding Talgo, the SGH analyses and report (Appendix A) indicate that, contrary to NTSB Findings 34 and 37,[23] the Talgo Series VI trainsets are for all practical purposes in full compliance with the latest FRA regulations. The structural integrity and crashworthiness of the Talgo Series VI trainsets is comparable to most equipment now in service and as safe as or safer than even the newest conventional Tier I equipment. In addition, SGH finds that NTSB erred in concluding that detachment of rolling assemblies is a hazard unique to the Talgo Series VI design, in blaming such detachment on the Talgo design, and in concluding that the only solution to the truck detachments is to remove Talgo Series VI trainsets from operations entirely.[24] The following sections highlight new evidence and analyses showing why the NTSB's findings and probable cause analysis relating to Talgo's structural design flaws are erroneous and unfounded.

1. The NTSB's findings about the Talgo Series VI railcars based on their failure to meet FRA standards were in error, as the Talgo railcars meet FRA crashworthiness and truck-to-carbody retention standards.

NTSB Findings 30, 31, 34, 35, 36, and 37 and Safety Recommendation R-19-017 all flow from the agency's erroneous conclusion that the Talgo Series VI trainsets fail to meet FRA

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[21] As set forth above, "static end strength" (49 CFR 238.203) compliance is by means of an FRA grandfathering decision, but this requirement was not relevant to any conditions that resulted from the DuPont derailment.

[22] If that were the case, all the Horizon, Amfleet, Superliner and Viewliner equipment, as well as most of the commuter cars should be removed immediately from service in the US.

[23] NTSB/RAR-19/01, Findings 34 ("The Talgo Series VI trainset is structurally vulnerable if it is involved in a high-energy derailment or collision due to its lack of crashworthiness protections and is at risk to severe and catastrophic loss of survivable space.") and 37 ("The Talgo Series VI trainset does not meet current United States safety standards and poses unnecessary risk to railroad passenger safety when involved in a derailment or collision.").

[24] *See id.* at 124, Probable Cause; *id.* at 126, Safety Recommendation R-19-017.

regulatory standards. The SGH Report (Appendix A) contradicts the very foundation of these findings. Its finite element stress and collision dynamics analyses and various other calculations demonstrate that the Talgo Series VI trainsets meet or exceed the current FRA regulations for crashworthiness, and exceed the FRA regulations for occupant volume strength. *See* 49 C.F.R. Part 238 & Appendix D. Specifically, the SGH Report shows that the Talgo railcars meet the current FRA structural requirements for all of the following:

Static-end strength/occupant volume, including both quasi-static compression loads and dynamic collision.[25] SGH shows that the Talgo Series VI carbody meets 49 CFR §§ 238.703 and 238.705 for occupant volume strength because the cars have the requisite crippling strength (1283 kips, greater than the required 1200 kips), maximum passenger car end deformation (7.5 in., less than the maximum 10 inches in the CFR-defined collisions), and buff strength (441 kips, greater than the required 337 kips). SGH also uses the new CFR alternative requirements to show that the Talgo Series VI carbody occupant volume strength is the same as that of conventional cars, and that the occupant volume of the Amtrak train 501 train configuration could sustain a 25 mph train-to-train collision, while the occupant volume of a conventional train would be compromised in a 15 mph train-to-train collision.

End-Load Crippling. SGH's finite element analysis provided a crippling load for Talgo Series VI railcars of approximately 1300 kips, and the test results from a 2017 FRA report provided a crippling load for conventional railcars of approximately 1100 kips.

Anti-climbing.[26] The required anti-climbing yield strength between cars is 100 kips for movement of one coupled end relative to the adjacent end. *See* 49 CFR § 238.205. The components providing primary vertical strength for Talgo Series VI railcars are the weight-bearer bars and the articulated connector. SGH's evaluation concludes that the weight-bearer bars' buckling strength is 155 kips, and the articulated connector yield strength is 82.1 kips, for a total minimum vertical yield strength of 237 kips.

Collision posts.[27] SGH concludes that Talgo Series VI trainset satisfies the CFR § 238.211 requirements because its articulated connections have vertical yield strength capable of preventing disengagement and telescoping to the same extent as equipment satisfying the CFR's anti-climbing and collision post requirements, and because having rolling assemblies (trucks) between the cars provides additional resistance against override.

Corner posts.[28] SGH's calculations show that the Talgo Series VI carbody meets the 49 CFR § 238.213 corner post requirements except for one case that SGH concludes had no bearing

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[25] SGH Report §§ 4.1.1, 4.1.2.

[26] *Id.* § 4.2.

[27] *Id.* § 4.3.

[28] *Id.* § 4.4. SGH identified one minor case of a longitudinal corner post load that had 70% of the 49 CFR § 238.213 requirement, but it found that this factor had no bearing on the outcome of the Amtrak train 501 derailment. That fourth corner is compliant at the top and the bottom and, except for one load case, at 18 inches above the floor. The exception is that SGH predicts a

on the outcome of the Amtrak train 501 derailment. Specifically, the carbody includes a base ultimate shear strength of 177 kips (greater than required 150 kips), a roof ultimate strength of 21 kips (greater than required 20 kips), and yield strength above top of underframe of 49 kips (greater than required 30 kips) at three of the four corners.

Rollover strength.[29] 49 CFR § 238.215 requires that, for a car resting on its side or roof, stresses shall be less than one-half the yield strength and one-half the critical buckling stress. Using finite element analysis calculations, SGH shows that the Talgo Series VI railcars satisfied these parameters with respect to rollover on both the side and on the roof.

Side impact strength. [30] SGH reviewed and found correct a Talgo report on its Series VI railcars' section moduli, concluding that the "skin" or aluminum extrusion of its railcars was 3 mm (0.118 in.) thick with a strength of 215 MPa (31 ksi). This exceeds the CFR sheathing requirement that 0.125 in. thick of open hearth steel have a strength of 24 ksi.

Attachment strength.[31] SGH finds that the truck-to-carbody attachment strength meets both of the possible CFR requirements (49 CFR §§ 238.219 or 238.717). In an evaluation under the dictates of § 238.219, SGH found longitudinal ultimate strength of 497 kips (greater than the required 250 kips), lateral ultimate strength of 471 kips (greater than the required 250 kips), and vertical ultimate strength of 308 kips (greater than the required 11.8 kips). Under § 238.717, SGH found longitudinal ultimate strength of 497 kips (greater than the required 124 kips), lateral ultimate strength of 471 kips (greater than the required 5.9 kips), and vertical ultimate strength of 308 kips (greater than the required 17.7 kips).

2. The Talgo railcars performed as well as or better than conventional railcars would have in high-speed rail accidents.

Many of the NTSB's findings about the Talgo Series VI railcars' performance during the accident are based on investigators' observations that several rolling assemblies (or "trucks") detached from the railcars during the accident.[32] The NTSB criticized the design of the Talgo trainset, and suggested that the Talgo design is uniquely susceptible to truck detachment:

> The unique design of the Talgo Series VI trainset rolling assembly and its vulnerability to detachment further contributed to the severity of secondary collisions. The observations in this derailment demonstrated that the rolling

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longitudinal load of 21 kip (versus the 30 kip required) at that (18 inch) point will cause the post to yield. A very small and easily accomplished modification to this post would bring it into full compliance with the latest requirements for new cars.

[29] *Id.* § 4.5.

[30] *Id.* § 4.6

[31] *Id.* § 4.7.

[32] *See* NTSB/RAR-19/01 § 2.6, Equipment Crashworthiness.

> assembly is prone to separation when the trainset's articulated connection fails. In this derailment, five rolling assemblies fully detached, and one partially detached.[33]

Although several trucks did separate during this accident, this was a result of the excessive speed at which the accident occurred, not the Talgo Series VI trainset design. As shown below and in the SGH Report, conventionally designed railcars involved in high-speed accidents also experience truck detachment and fatal injuries comparable to or worse than the DuPont crash, and it is error to associate the detachment of rolling assemblies in high-energy accidents with one particular brand or manufacturer.

SGH reviewed previous accidents involving conventional railcar designs from news sources, press releases, and prior NTSB reports. Contrary to the quoted NTSB statement above, the Talgo Series VI trainsets are not uniquely susceptible to truck detachment. Accidents involving conventional car designs also experience truck detachment when involved in high-speed accidents, as shown by the following accident photos. Notably, none of the below accidents involving truck detachments featured a vertical drop from a bridge or overpass like that experienced by the Amtrak train 501 railcars. And as discussed below in Part B.3, the NTSB's accident reports on the below derailments at most mention the truck detachment(s) in their accident narrative, do not include findings or recommendations related to such detachments, and do not find that such detachments warrant either design modifications or discontinuation of entire railcar lines.

Metrolink Collision with SUV, Glendale, CA (January 26, 2005)

Train impact with an obstacle and a freight train at 63 mph—11 fatalities, >100 injured.**[34]**

[33] *Id.* at 99.

[34] *See* U.S. DOT, Volpe National Transportation Systems Center, *Crashworthiness analysis of the January 26, 2005 Glendale, California rail collision (March 3, 2016)*, *at* https://rosap.ntl.bts.gov/view/dot/9125.

Amtrak Train 188, Philadelphia, PA (May 12, 2015)
Train derailed at 106 mph on curve with speed restriction of 50 mph—8 fatalities, 159 injuries.[35]

Amtrak Train 55, Northfield, VT (October 5, 2015)
Train derailed at 59 mph after striking an obstruction--7 injuries.[36]

[35] *See* NTSB RAR 1602, *Derailment of Amtrak Passenger Train 188 Philadelphia, Pennsylvania (May 12, 2015)*, *at* https://www.ntsb.gov/investigations/AccidentReports/Reports/RAR1602.pdf.

[36] *See* NTSB RAB 1703, *(Amtrak) Passenger Train 55 Collision with Rocks and Subsequent Derailment* (adopted June 7, 2017), *at* https://www.ntsb.gov/investigations/AccidentReports/Reports/RAB1703.pdf.

Amtrak-CSX Collision, Cayce, SC (February 4, 2018)

A southbound train diverted from the main track into a siding and collided head-on with a stationary freight train while traveling 53 m.p.h.—2 fatalities, 92 injuries.[37]

These real-life scenarios also support the argument above that structural features of Talgo's Series VI trainset actually enhance passenger safety, as evidenced by the number of fatalities and injuries that have happened in the above accidents under similar (or better) speeds and conditions. The reasons the Talgo equipment behaves better than conventional equipment in high-speed accidents stem from the lightweight material of the structural elements, the low center of gravity of the consist, and the articulated connections between the railcars. Those features reduce the energy to be dissipated, and prevent overriding and telescoping, which are key effects involved in the severity of accidents to passengers. The NTSB's final accident report fails to identify the advantages of the design, and chooses to stress effects (truck detachment) that are erroneously attributed exclusively to the Talgo Series VI equipment, which in this instance occurred at one of the highest accident speeds investigated in recent memory by the NTSB.

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Given the analyses above and evidence from other accidents involving conventional, U.S.-designed cars, NTSB Finding 34 that "the Talgo Series VI trainset is structurally vulnerable if it is involved in a high-energy derailment or collision due to its lack of crashworthiness protections and is at risk to severe and catastrophic loss of survivable space," is misleading at best. In high-speed derailments or collisions, such as the 78 mph derailment along a 30 mph

[37] *See* NTSB RSR 1801, *Train Operation During Signal Suspension* (adopted Feb. 13, 2018), *at* https://www.ntsb.gov/investigations/AccidentReports/Reports/RSR1801.pdf.

limited curve as experienced at DuPont, Washington, all railcars are at risk, regardless of the manufacturer, and regardless whether they are conventionally designed or based on energy absorption principles. Neither conventional nor Talgo-designed railcars are designed to withstand accidents at the 78 mph speed experienced by Amtrak train 501.

Testing on the NTSB investigation docket substantiates this fact. As noted by the report of Tyrell & Tsai, the safe closing speed for conventional railcars is only 15 mph, while trains utilizing Crash Energy Management (CEM) have safe closing speeds of 25 mph.[38] In a 2002 simulated train collision analysis, Volpe National Transportation Systems Center showed that for a 50 mph accident, the maximum crush in the first passenger car of the Talgo Series VI train was only 7 feet, compared to 19 feet of crush in the first passenger car of a conventional train.[39] Thus, Volpe showed that the Talgo Series VI railcars performed better than conventional railcars in the highest-speed crush comparison we have to date: an outcome we have seen play out in comparable derailments.

C. In other high-speed accidents involving conventional railcars whose trucks separated or whose crashworthiness or occupant-protection designs were found inadequate, the NTSB did not recommend removing those railcars from service.

Beyond the evidence contained on the investigation docket and in the new SGH Report, Talgo also notes that the NTSB's recommendation that the Talgo Series VI trainsets be removed from service is unprecedented and entirely unfounded. During its investigation, the NTSB failed to take the necessary steps to understand a railcar design that it was far less familiar with than conventional U.S.-designed railcars. In fact, as seen in the omission of Talgo as a participant in the July 2018 hearing, declining Talgo's numerous requests to meet, and the mishandling of the Talgo Party Submission, the NTSB affirmatively declined to hear and consider much-needed Talgo expertise on its design. Perhaps owing to the NTSB's unfamiliarity with—and, at times, clear predisposition against[40]—the Talgo technology, the agency elected to recommend outright removal of the Talgo trainsets from service, rather than modifications, improvements, or further analysis thereof. There is no support on the record for the NTSB's unwarranted "leap" to recommend removal, and this recommendation does not align with the NTSB's approach toward manufacturers in prior accident reports.

As shown in the derailment examples above, truck detachment during high-speed accidents is not a phenomenon unique to the Talgo Series VI trainset's design. The NTSB and DOT have reported on accidents involving high-speed derailments and collisions of conventional

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[38] SGH Report § 2.9 (discussing Tyrell., D., Tsai., T., "Improved Crashworthiness of Rail Passenger Equipment in the United States," World Congress on Railway Research, Montreal, Canada, June 2006). CEM has no bearing in this accident, as the reported speed of train 501 was 78 mph.

[39] *Id.* § 2.6.

[40] Talgo personnel involved in the investigation observed a number of instances in which NTSB investigators exhibited a predisposition against Talgo equipment and personnel. *See* Appendix C, Declaration of Joshua D. Coran, ¶¶ 3-7.

railcar designs in which evidence of truck detachment was well documented, including the derailment in Cayce, South Carolina that was examined at the same investigative hearing as the Amtrak train 501 accident. The accidents depicted above show such truck detachments, and most involve similar or greater numbers of fatalities or injuries in relation to the derailment speed than the Amtrak train 501 derailment.

The NTSB did not recommend removing the railcars from service in any of the accidents featured above. Notably, in the final accident report on the Amtrak train 188 derailment near Philadelphia, the NTSB addressed crashworthiness and occupant protection standards, and made recommendations to the FRA regarding the same, but it did not recommend removing the railcars at issue from service.[41] Particularly relevant to the present petition is the NTSB's acknowledgement that "[t]he [Amtrak train 188] railcars involved in this [Philadelphia] accident were manufactured in the 1970s and, therefore, were not subject to the current passenger equipment safety regulations," including those relating to structural and interior crashworthiness.[42] Of the seven passenger cars that derailed, "the structure of the first car [in which four people died] was catastrophically compromised," and the remaining four fatalities were attributed to full or partial ejection due to window separations in the third passenger car.[43] But rather than seeking to eliminate the passenger railcars themselves, the NTSB simply recommended that FRA perform research to improve occupant protection standards and to ensure that passenger railcars abide by such standards.[44]

Among other accident reports in which the NTSB expressed concerns similar to those in the Amtrak train 501 derailment, Talgo found no other instance in which the NTSB

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[41] *See* NTSB/RAR-16/02, Derailment of Amtrak Passenger Train 188 Philadelphia, Pennsylvania (May 12, 2015) § 3.2, Probable Cause.

[42] *Id.* at 27.

[43] *Id.* at 22 (Survival Factor 1.8.1), 25 (Survival Factor 1.8.2).

[44] *Id.* at 45-47, Safety Recommendations R-16-35 ("Conduct research to evaluate the causes of passenger injuries in passenger railcar derailments and overturns and evaluate potential methods for mitigating those injuries"), R-16-36 ("Use the findings to develop occupant protection standards for passenger railcars that will mitigate passenger injuries likely to occur during derailments and overturns."), and R-14-74 ("Develop a performance standard to ensure that windows . . . are retained in the window opening structure during an accident and incorporate the standard into [the CFR] to require that passenger railcars meet this standard.").

Likewise, in the December 1, 2013 crash of a Metro-North passenger train near Bronx, NY, the NTSB found that the loss of window glazing resulted in the fatal ejection of four passengers from the train and the near-fatal ejection of others, but did not include recommendations regarding the windows or the railcars that housed them. Instead, the NTSB recommended only that FRA "[d]evelop a performance standard to ensure that windows . . . are retained in the window opening structure during an accident and incorporate the standard into 49 Code of Federal Regulations (CFR) 238.221 and 49 CFR 238.421 to require that passenger railcars meet this standard." NTSB RAB-14-15, Safety Recommendation R-14-074.

recommended outright removal of rail equipment from service. Typically when component design plays a role in an accident or is alleged not to meet regulatory standards, instead of recommending removal from service, the NTSB recommends review of the designs, bringing equipment into regulatory compliance, and research on crashworthiness.[45] For example, in its investigation of the Collision of Illinois Central Gulf Railroad Commuter Trains on October 30, 1972,[46] the NTSB determined that the collision posts of "the highliner car involved in the collision . . . did not meet the requirements of the Federal regulations."[47] It recommended that the FRA, "review the current design of the collision posts . . . and determine whether the attachments comply with the requirements of [federal regulations]" and "[t]ake the necessary enforcement action to assure that highliner cars meet the requirements."[48] The NTSB also recommended that FRA and the Urban Mass Transportation Administration "initiate research to develop the technical approaches to crashworthiness . . . ."[49] In its investigation of the 2002 collision of a Burlington Northern Santa Fe Freight Train with a Metrolink Passenger Train in Placentia, CA, the NTSB noted "Metrolink cars . . . derailed and sustained substantial crush damage," and "skewed onto the adjacent track."[50] Track fouling in that accident was not a focus of the report, nor were the findings used as part of a rationale for removing cars from service.

D. Talgo requests the following revisions to the NTSB findings, safety recommendations, and probable cause determinations.

As demonstrated by the discussion above and the SGH Report, contrary to NTSB findings and conclusions, the Talgo Series VI railcars meet current FRA structural safety regulations. The high speed at which Amtrak train 501 derailed caused the severity of the accident and the accompanying injuries and fatalities, and the Talgo Series VI cars performed at least as well as conventional U.S.-designed cars would have. Thus, Talgo recommends revision, cancellation, or closing of the following findings, safety recommendations, and the probable cause statement in NTSB/RAR-19/01.

1. Revise NTSB Findings from the DuPont accident.

Delete findings 30, 31, 34, 35, 36, and 37, or alternatively, modify them as follows:

30. The Talgo Series VI passenger railcar AMTK 7424 (8)'s ~~did not provide adequate occupant protection after its~~ articulated connections separated, resulting in complex uncontrolled movements and secondary collisions with the surrounding

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[45] *See* Safety Recommendations R-73-013 & R-73-031.

[46] NTSB RAR-73-05 (June 28, 1973).

[47] Safety Recommendation R-73-013, at 1, 3-4 (April 25, 1973), *available at* https://www.ntsb.gov/safety/safety-recs/recletters/R73_13_14.pdf.

[48] Safety Recommendation R-73-013, at 4.

[49] Safety Recommendation R-73-030, at 1 (June 28, 1973), *available at* https://www.ntsb.gov/safety/safety-recs/recletters/R73_28_32.pdf.

[50] RAR-03-04 at 12 & 16 (October 7, 2003).

environment~~ which led to damage so severe to the railcar body structure, that it caused passenger ejections~~.

31. ~~The failure of the articulated connections of both Talgo Series VI passenger railcars AMTK 7422 (10) and AMTK 7504 (7), the detached rolling assembly from AMTK 7422 (10) and its secondary collision with AMTK 7504 (7) directly resulted in three fatalities and two partially ejected passengers who had been traveling in AMTK 7504 (7).~~ The Talgo Series VI passenger railcars AMTK 7422 (10) and AMTK 7504 (7)'s articulated connections separated, and the detached rolling assembly from AMTK 7422 came to rest in AMTK 7504 after the bridge breached the side wall of AMTK 7504.

34. ~~The Talgo Series VI trainset is structurally vulnerable if it is involved in a high-energy derailment or collision due to its lack of crashworthiness protections and is at risk to severe and catastrophic loss of survivable space.~~

35. ~~The Talgo Series VI trainset designated as Amtrak train 501 was not in compliance with the terms and conditions of the Federal Railroad Administration's grandfathering agreement.~~

36. ~~Allowing the grandfathering provision to remain in Title 49 *Code of Federal Regulations* 238.203(d), "Grandfathering of noncompliant equipment for use on a specified rail line or lines," is an unnecessary risk that is not in the public interest nor consistent with railroad safety.~~

37. ~~The Talgo Series VI trainset does not meet current United States safety standards and poses unnecessary risk to railroad passenger safety when involved in a derailment or collision.~~

2. Reconsider and Close the Safety Recommendations to Washington State Department of Transportation and FRA.

Close as reconsidered Safety Recommendation R-19-017, to the Washington State Department of Transportation, which currently states: "Discontinue the use of the Talgo Series VI trainsets as soon as possible and replace them with passenger railroad equipment that meet all current United States safety requirements"; and Safety Recommendation R-19-012, to the Federal Railroad Administration, which currently states: "Remove the grandfathering provision within Title 49 Code of Federal Regulations 238.206(d), and require all railcars comply with the applicable current safety standards."

3. Revise the Probable Cause statement to remove the contributing cause, which is based on erroneous conclusions about the regulatory compliance of the Talgo Series VI trainsets.

Revise the Probable Cause statement by striking the last sentence:

> The National Transportation Safety Board determines that the probable cause of the Amtrak 501 derailment was Central Puget Sound Regional Transit Authority's failure to provide an effective mitigation for the hazardous curve without positive train control in place, which allowed the Amtrak engineer to enter the 30-mph curve at too high of a speed due to his inadequate training on the territory and inadequate training on the newer equipment. Contributing to the accident was the Washington State Department of Transportation's decision to start revenue service without being assured that safety certification and verification had been completed to the level determined in the preliminary hazard assessment. ~~Contributing to the severity of the accident was the Federal Railroad Administration's decision to permit railcars that did not meet regulatory strength requirements to be used in revenue passenger service, resulting in (1) the loss of survivable space and (2) the failed articulated railcar-to-railcar connections that enabled secondary collisions with the surrounding environment causing severe damage to railcar-body structures which then failed to provide occupant protection resulting in passenger ejections, injuries, and fatalities.~~

4. Issue a press release with a statement that describes the foregoing errors and corrections.

The NTSB has made fundamental engineering and investigative errors in the investigation of the Amtrak train 501 derailment and publication of the final accident report. The errors made by the NTSB have the great potential to cause other operators to unjustifiably lose confidence in Talgo's product designs and accident mitigation performance. This poses the grave risk that the NTSB's erroneous findings will actually undermine the continued usage of products that in reality have better safety performance than many traditional designs now in use elsewhere in the United States. This bias toward a U.S.-centric view of railcar safety design and accident mitigation poses its own risks to safety across the rail industry worldwide. If the pursuit of transportation safety via the thorough and precise investigation of transportation accidents is truly the overarching mission of the NTSB, then Talgo respectfully suggests that the scientific, engineering, and regulatory assessments documented in this petition should be more than sufficient to prompt a reevaluation of the NTSB's conclusions in this investigation. If the NTSB reconsiders its findings, then, at a minimum, the NTSB should wish to publicize the corrections with the same level of media distribution as when the NTSB final report was issued.

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For the reasons set forth above, including the evidence and analysis incorporated from the SGH Report, Talgo petitions the NTSB to reconsider and modify its report on the Amtrak train 501 derailment near DuPont, Washington, on December 18, 2017.

While the NTSB rules state that oral presentations are not required, Talgo requests an opportunity to meet with the NTSB investigators considering this Petition and the NTSB Board Members to assist in their understanding of the information contained herein. Copies of this petition and supporting documentation have been provided to all other parties to the NTSB investigation as required by 49 C.F.R. § 845.32(c).

Appendix A

Analysis of the Crashworthiness of the Talgo Series VI Cars and the Related NTSB Conclusions in the Investigation of the Train Derailment Near Dupont, Washington on 18 December 2017

(NTSB Inv. No. RRD18MR001)

25 October 2019

SGH Project 190911

SIMPSON GUMPERTZ & HEGER

Engineering of Structures and Building Enclosures

PREPARED FOR:

Hunton Andres Kurth
2200 Pennsylvania Avenue. NW
Washington, DC 20017

PREPARED BY:

Simpson Gumpertz & Heger Inc.
480 Totten Pond Road
Waltham, MA 02451
Tel: 781.907.9000
Fax: 781.907.9009

SIMPSON GUMPERTZ & HEGER
Engineering of Structures
and Building Enclosures

25 October 2019

Mr. Ryan P. Phair
Hunton Andres Kurth LLP
2200 Pennsylvania Avenue NW
Washington, DC 20017

Project 190911 – Analysis of the Crashworthiness of the Talgo Series VI Cars and the Related NTSB Conclusions in the Investigation of the Train Derailment Near Dupont, Washington on 18 December 2017
(NTSB Inv. # No. RRD18MR001)

Dear Mr. Phair:

Enclosed is Simpson Gumpertz & Heger Inc.'s final report for the above-referenced project.

Sincerely yours,

[redacted]

Ronald A. Mayville
Senior Principal
I:\BOS\Projects\2019\190911.00-TREN\WP\001RAMayville-L-190911.00.sco.docx

Encls.

EXECUTIVE SUMMARY

On 18 December 2017, Amtrak train 501, traveling at 78 mph into an 8° curve with a speed limit of 30 mph, derailed. The train consisted of ten Talgo Series VI passenger cars, a power car, a baggage car, and a locomotive at each end. There were three passenger fatalities and approximately 46 injuries. The National Transportation Safety Board (NTSB) issued its formal report on this accident with 53 findings, including: "The Talgo Series VI trainset does not meet current United States safety standards and poses unnecessary risk to railroad passenger safety when involved in a derailment or collision." The NTSB recommended that the Washington State Department of Transportation discontinue use of the Talgo VI trainsets as soon as possible.

Talgo engaged Simpson Gumpertz & Heger Inc. (SGH) to conduct an independent evaluation of the structural crashworthiness of the Talgo Series VI rail vehicle carbody that makes up the trainset. We reviewed project information and technical literature and conducted finite element stress and collision dynamics analyses and calculations in support of our crashworthiness assessment.

We find that the Talgo Series VI carbody meets or exceeds the current structural crashworthiness requirements of Part 238 of the Code of Federal Regulations (CFR) applicable to newly manufactured equipment except for one minor case of a longitudinal corner post strength, which had no bearing on the outcome of the 18 December 2017 derailment. Our calculations and review of Talgo engineering documents show the Talgo Series VI cars meet or exceed the CFR requirements for occupant volume, (static end) strength, anticlimbing, collision posts, rollover and side strength, and truck-to-carbody attachment strength.

The NTSB erred in several of their statements included in the accident report. The report claimed that the requirement that carbodies have an 800,000 lb buff strength effectively eliminated complete structural collapse; this is contrary to the consequences of the Glenndale and Frankford Junction accidents involving 800,000 lb buff strength cars. The NTSB also failed to recognize the internationally accepted (including in the US) energy absorption-based requirements as providing substantially greater safety to passengers than strength-based requirements. They implied that the Talgo Series VI carbody is the only carbody without collision and corner posts. Other US articulated trainsets do not have collision posts, and US carbodies built from aluminum extrusions do not have the classical corner "post" structures yet provide protection comparable to that of conventional carbodies.

We find that the crashworthiness of the Talgo Series VI carbody is comparable to or better than that of conventional Tier I carbodies designed and fabricated to the current CFR requirements. We found evidence of truck detachments from conventional trains in high-speed accidents comparable to what occurred in the 18 December 2017 derailment. We conducted calculations using the new CFR alternative requirements to show that the Talgo Series VI carbody occupant volume strength is the same as that of conventional cars and that the Cascade Service Talgo train configuration could sustain a 25 mph train-to-train collision, while the occupant volume of a conventional train would be compromised in a train-to-train collision at speeds as low as 15 mph.

We find that the NTSB's conclusion that the Talgo Series VI trainset poses unnecessary risk to railroad passenger safety is incorrect.

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1. INTRODUCTION

1.1 Background

On 18 December 2017, Amtrak train 501 derailed while traveling at 78 mph into an 8° curve with a speed limit of 30 mph. The train consisted of ten Talgo Series VI passenger cars, a power car, a baggage car, and a locomotive at each end. There were three fatalities and approximately 46 injuries among the train passengers and bystanders.

The NTSB issued its final report on this accident on 24 June 2019. Among its 53 findings, the NTSB stated: "The Talgo Series VI trainset is structurally vulnerable if it is involved in a high-energy derailment or collision due to its lack of crashworthiness protections and is at risk to severe and catastrophic loss of survivable space." Furthermore, the NTSB stated: "The Talgo Series VI trainset does not meet current United States safety standards and poses unnecessary risk to railroad passenger safety when involved in a derailment or collision." The NTSB recommended that the Washington State Department of Transportation "discontinue the use of the Talgo Series VI trainsets as soon as possible . . . ."

1.2 Scope of Work

Talgo engaged SGH to conduct an independent evaluation of the structural crashworthiness of the Talgo Series VI carbody. SGH performed the following scope of work:

- Reviewed project information (drawings and reports)
- Reviewed Talgo reports on structural calculations
- Reviewed technical literature on crashworthiness and methods of structural evaluation
- Conducted finite element analysis in support of crashworthiness calculations
- Interviewed Talgo engineers
- Prepared this report on our findings

1.3 Format of This Report

The format of this report is to first provide factual information from our review of existing documents and analysis of structural behavior of the Talgo Series VI carbody. This is followed by discussion and conclusions of the implications of this review and analysis.

2. DOCUMENT REVIEW

2.1 Railroad Accident Report, Amtrak Train 501 Derailment, DuPont, Washington, December 18, 2017, NTSB/RAR-19/01, PB2019-100807 (21 May 2019) 139 pages

The NTSB final report describes the circumstances and consequences of the 18 December 2017 high-speed derailment involving Talgo Series VI cars. The report has 53 findings, a probable cause determination, and 26 recommendations. Among the findings and recommendations are:

- Finding 34. “The Talgo Series VI trainset is structurally vulnerable if it is involved in a high-energy derailment or collision due to its lack of crashworthiness protections and is at risk to severe and catastrophic loss of survivable space.”
- Finding 37. “The Talgo Series VI trainset does not meet current United States safety standards and poses unnecessary risk to railroad passenger safety when involved in a derailment or collision.”
- Recommendation R-19-17 to the Washington State Department of Transportation: “Discontinue the use of the Talgo Series VI trainsets as soon as possible and replace them with passenger railroad equipment that meet all current United States safety requirements.”

2.2 Previous Accident Reports

The NTSB report on the DuPont, Washington accident notes the truck separation in the Talgo Series VI trainset, and suggests the Talgo trainset’s “unique design … contributed to the severity of secondary collisions,” from the truck separation in a way that would not have occurred in conventional cars (NTSB/RAR-19/01 p. 99). Such an inference is not supported by the evidence from high-speed accidents involving conventional U.S. designed cars.

We reviewed U.S. news sources, press releases, and past NTSB reports to identify accidents in which trucks detached from passenger rail cars of conventional design for Tier I service. For each such accident, we list the location and date of the accident, the speed and general train trajectory, the source of information, and a photograph showing a detached truck. We did not review all U.S. train accidents, and the accidents described below likely represent only part of the set in which trucks have detached.

Glendale, CA, 26 January 2005

Train impact with an obstacle and a freight train at 63 mph. These rail cars satisfied the 800,000 lb buff strength and 250,000 truck-to-carbody strength requirements.

https://rosap.ntl.bts.gov/view/dot/9125

Frankford Junction, Pennsylvania, 12 May 2015

Train derailed at 106 mph in a curve with speed restriction of 50 mph. These rail cars satisfied the 800,000 lb buff strength and 250,000 truck-to-carbody strength requirements.

https://www.ntsb.gov/investigations/AccidentReports/Reports/RAR1602.pdf

Northfield, Vermont, 5 October 2015

Train derailed at 59 mph after striking an obstruction. These rail cars satisfied the 800,000 lb buff strength and 250,000 truck-to-carbody strength requirements.

https://www.ntsb.gov/investigations/AccidentReports/Reports/RAB1703.PDF

Cayce, South Carolina, 4 February 2018

A southbound train diverted from the main track into a siding and collided head-on with stationary freight train. These rail cars satisfied the 800,000 lb buff strength and 250,000 truck-to-carbody strength requirements.

https://www.ntsb.gov/investigations/AccidentReports/Reports/RSR1801.pdf

2.3 Current CFR Requirements on Crashworthiness of Tier I Trainsets

Tier I passenger trains – trains operating at speeds not exceeding 125 mph – are required by the Code of Federal Regulations (CFR) to satisfy several structural requirements related to crashworthiness. These requirements are provided in Subpart C of 49 CFR Part 238. Table 2.1 lists the CFR requirements as of June 2019 that are currently applicable to Tier I cars. Talgo cars are part of a semi-permanently coupled articulated trainset. We have not included cab car requirements because the Talgo Series VI cars operate in locomotive-led trains or, in push-pull mode, with a locomotive-like cab car (Amtrak NPCU) in the lead. Talgo Series VI trains are currently restricted to operating at speeds not exceeding 79 mph.

Table 2.1 – 49 CFR Part 238, Subpart C Requirements for Tier I Trainsets (Excluding Cab Car Requirements)

CFR Section	Title	Requirement Summary
§238.201(b)	Scope/alternative compliance	See text below
§238.203	Static end strength	800,000 lb yield strength on the line of draft
§238.205	Anticlimbing mechanism	100,000 lb yield strength for upward or downward loading
§238.207	Link between coupling mechanism and carbody	Articulated equipment must satisfy §238.205
§238.211	Collision posts	No collision posts are required if the articulated connection is capable of preventing disengagement and telescoping to the same extent as equipment satisfying the anti-climbing and collision post requirements contained in this subpart
§238.213	Corner posts	150,000 lb base ultimate shear strength; 20,000 lb ultimate strength at the roof; 30,000 lb yield strength applied at 18 in. above the top of the underframe
§238.215	Rollover strength	Car resting on its side or roof with stresses less than one-half the yield strength and one-half the critical buckling stress
§238.217	Side strength	Section moduli of side structural elements must satisfy quantitative values (see Section 4.6 of this report); side sheathing equivalent to 0.125 in. of open hearth steel
§238.219	Truck-to-carbody attachment	250,000 lb horizontal ultimate strength; 2g vertical ultimate strength

Section §238.201(b), Alternative compliance, includes the following requirements:

> §238.201(b)(1): Passenger equipment of special design shall be deemed to comply with this subpart [that is, Subpart C], other than §238.203, for the service environment the petitioner proposes to operate the equipment in if the Associate Administrator determines under paragraph (c) of this section that the equipment provides at least an equivalent level of safety in such environment for the protection of its occupants from serious injury in the case of a derailment or collision. In making a determination under paragraph (c) the Associate Administrator shall consider, as a whole, all of those elements of casualty prevention or mitigation relevant to the integrity of the equipment that are addressed by the requirements of this subpart.
>
> §238.201(b)(2)(i): Tier I passenger trainsets may comply with the alternative crashworthiness and occupant protection requirements in appendix G to this part instead of the requirements in §§238.203, 238.205, 238.207, 238.209(a), 238.211, 238.213, and 238.219.

There are additional sections related to the information that must be provided to the Associate Administrator as part of demonstrating alternative compliance according to §238.201(b). These include test plans, analysis, and reporting requirements.

Part 238 Appendix G, Alternative Requirements for Evaluating the Crashworthiness and Occupant Protection Performance of Tier I Passenger Trainsets, incorporates requirements for Tier III trainsets, §238.703 and §238.705, to demonstrate crashworthiness. (Tier III trainsets are trainsets that may operate in shared rights-of-way at speeds not exceeding 125 mph and in exclusive rights-of-way without grade crossings at speeds exceeding 125 mph but not exceeding 220 mph.) Appendix G references the following requirements:

> §<u>238.703</u>: Quasi-static compression load requirements.
> (a) General. To demonstrate resistance to loss of occupied volume, Tier III trainsets shall comply with both the quasi-static compression load requirements in paragraph (b) of this section and the dynamic collision requirements in §238.705
> (b) Quasi-static compression load requirements.
>> (1) Each individual vehicle in a Tier III trainset shall resist a minimum quasi-static end load applied on the collision load path of:
>>> (i) 800,000 pounds without permanent deformation of the occupied volume; or
>>> (ii) 1,000,000 pounds without exceeding either of the following two conditions:
>>>> (A) Local plastic strains no greater than 5 percent; and
>>>> (B) Vehicle shortening no greater than 1 percent over any 15-foot length of the occupied volume; or
>>>
>>> (iii) 1,200,000 pounds without crippling the body structure. Crippling of the body structure is defined as reaching the maximum point on the load-versus-displacement characteristic
>>
>> (2) To demonstrate compliance with this section, each type of vehicle shall be subjected to an end compression load (buff) test with an end load magnitude no less than 337,000 lbf (1500 kN)

> §<u>238.705</u>: Dynamic collision scenario
> (a) *General.* In addition to the requirements of §238.703, occupied volume integrity (OVI) shall also be demonstrated for each individual vehicle in a Tier III trainset through an evaluation of a dynamic collision scenario in which a moving train impacts a standing train under the following conditions:
>> (1) The initially-moving trainset is made up of the equipment undergoing evaluation at its AW0 ready-to-run weight;
>> (2) If trainsets of varying consist lengths are intended for use in service, then the shortest and longest consist lengths shall be evaluated;
>> (3) If the initially-moving trainset is intended for use in push-pull service, then, as applicable, each configuration of leading vehicle shall be evaluated separately;
>> (4) The initially-standing train is led by a rigid locomotive and also made up of five identical passenger coaches having the following characteristics:
>>> (i) The rigid locomotive weighs 260,000 pounds and each coach weighs 95,000 pounds;
>>> (ii) The rigid locomotive and each passenger coach crush in response to applied force as specified in Table 1 to this section [not repeated here]; and

(iii) The rigid locomotive shall be modeled using the data inputs listed in appendix H to this part so that it has a geometric design as depicted in Figure 1 to appendix H to this part;

(5) The scenario shall be evaluated on tangent, level track;

(6) The initially-moving trainset shall have an initial velocity of 20 mph if it is an integrated trainset, or an initial velocity of 25 mph if the lead vehicle of the trainset is not part of the integrated design;

(7) The coupler knuckles on the colliding equipment shall be closed and centered;

(8) The initially-moving trainset and initially-standing train consists are not braked;

(9) The initially-standing train has only one degree-of-freedom (longitudinal displacement); and

(10) The model used to demonstrate compliance with the dynamic collision requirements must be validated. Model validation shall be documented and submitted to FRA for review and approval.

(b) Dynamic collision requirements. As a result of the impact described in paragraph (a) of this section—

(1) One of the following two conditions must be met for the occupied volume of the initially-moving trainset:

(i) There shall be no more than 10 inches of longitudinal permanent deformation; or

(ii) Global vehicle shortening shall not exceed 1 percent over any 15-foot length of occupied volume.

The current CFR also includes alternative requirements for truck-to-carbody attachment strength:

§238.717: Truck-to-carbody attachment

To demonstrate the integrity of truck-to-carbody attachments, each unit in a Tier III trainset shall:

(a) Comply with the requirements in §238.219; or

(b) Have a truck-to-carbody attachment with strength sufficient to resist, without yielding, the following individually applied, quasi-static loads on the mass of the truck at its CG:

(1) 3g vertically downward;

(2) 1g laterally, along with the resulting vertical reaction to this load; and

(3) Except as provided in paragraph (c) of this section, 5g longitudinally, along with the resulting vertical reaction to this load, provided that for the conditions in the dynamic collision scenario described in §238.705(a):

(i) The average longitudinal deceleration at the CG of the equipment during the impact does not exceed 5g; and

(ii) The peak longitudinal deceleration of the truck during the impact does not exceed 10g.

(c) As an alternative to demonstrating compliance with paragraph (b)(3) of this section, the truck shall be shown to remain attached after a dynamic impact under the conditions in the collision scenario described in §238.705(a).

(d) For purposes of paragraph (b) of this section, the mass of the truck includes axles, wheels, bearings, truck-mounted brake system, suspension system components, and any other component attached to the truck by design.

(e) Truck attachment shall be demonstrated using a validated model

2.4 EN15227, Railway Applications – Crashworthiness Requirements for railway Vehicle Bodies

This European Norm (standard) provides requirements for rail vehicles based upon the principle of crash energy management (CEM). Rail vehicles are required to absorb collision energy in a variety of simulated collision scenarios. This standard has been in place since 2008 and is used by many countries, including all countries within the European Union.

2.5 FRA Report, Technical Criteria and Procedures for Evaluating the Crashworthiness and Occupant Protection Performance of Alternatively Designed Passenger Rail Equipment for Use in Tier I Service, DOT/FRA/ORD-11/22, Final Report (October 2011), 177 pages

This report provides guidance on methods to evaluate trainsets with respect to 49 CFR §238.703 and §238.705. It includes the recommendation:

- Explicit finite element analysis simulating quasi-static loading is required to show that the ratio of kinetic energy to strain (internal) energy is less than 5%.

2.6 Crashworthiness Evaluation of Amtrak's Talgo VI Train, Final Report to the Volpe National Transportation Systems Center (February 2002), 124 pages

This report, produced by Arthur D. Little, Inc. (ADL), provides an evaluation of the crashworthiness of the Talgo Series VI cars using methodologies that were state-of-the-art at the time of its writing. The evaluation was part of work required to grandfather the Talgo VI cars.

The evaluation included nonlinear, dynamic finite element analysis to establish the crush response of the ends of the Talgo Series VI cars. The results of that individual vehicle crush analysis are shown in Figure 2.1 below. We utilize for our current evaluation the crush responses for the supported and suspended ends (referred to as the Muelles and Portapesos ends, respectively, in the ADL report). The initial part of the crush curve, the first 0.33 ft (4 in.) corresponds to failure and deformation of the bolted articulated connection. This is followed by crush of the carbody at a relatively constant load of about 1,100 kips (a kip is equal to 1,000 lbs) and then buckling of the carbody at substantially lower loads.

ADL conducted train collision analyses for a simulated closing speed of 50 mph. In this case, ADL found that the maximum crush in the first passenger car of the Talgo VI train was 7 ft, compared to 19 ft in the first passenger car of a conventional train.

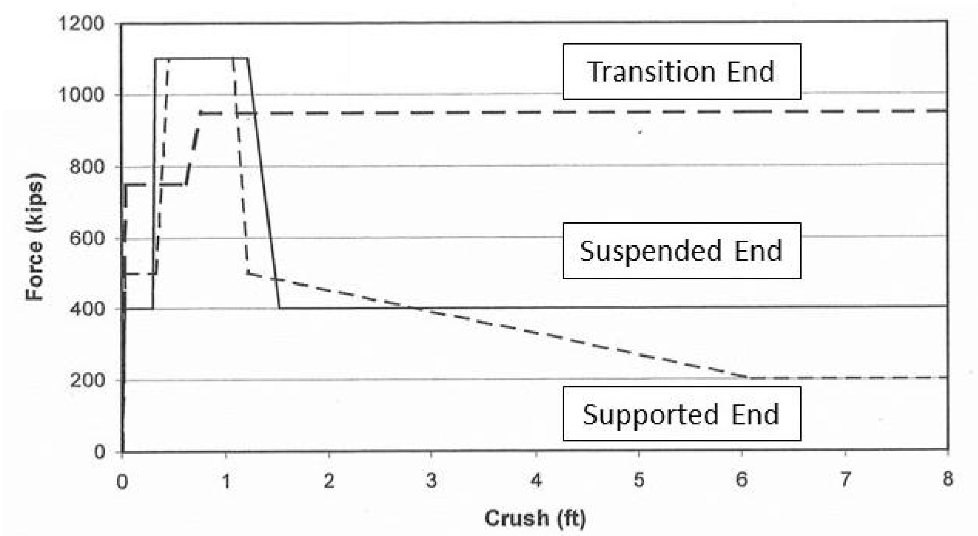


Figure 2.1 – Talgo VI Car End Crush Responses

2.7 Llana, P., Stringfellow, R., and Mayville, R.,"Finite Element Analysis and Full-Scale Testing of Locomotive Crashworthy Components," JRC2013-2546 (15 – 18 April 2013), 11 pages

This paper includes the load-crush response for a CEM system that is the basis for the CEM system included on the Charger locomotive used in the Talgo Series VI trainsets. We used this response in our collision dynamics model.

2.8 FRA Report, Passenger Car Crippling End-Load Test and Analyses, DOT/FRA/ORD-17/14, Final Report (September 2017), 210 pages

This report includes both test and analysis results on the crippling load of a conventional rail car that satisfied the CFR Tier I requirements. The finite element analyses provided a crippling load of approximately 1,300 kips, and the test results provided a crippling load of approximately 1,100 kips.

2.9 Tyrell., D., Tsai., T., "Improved Crashworthiness of Rail Passenger Equipment in the United States," World Congress on Railway Research, Montreal, Canada, June 2006

This paper includes an evaluation of the safe closing speed for conventional trains that meet the CFR crashworthiness requirements. It is based upon research conducted at the Volpe National Transportation Systems Center (Volpe Center). Figure 2 from this report, reproduced in Figure 2.2 below, shows that the safe closing speed is only approximately 15 mph for a cab car leading consist of convention cars, while trains utilizing CEM are safe at or above 25 mph.

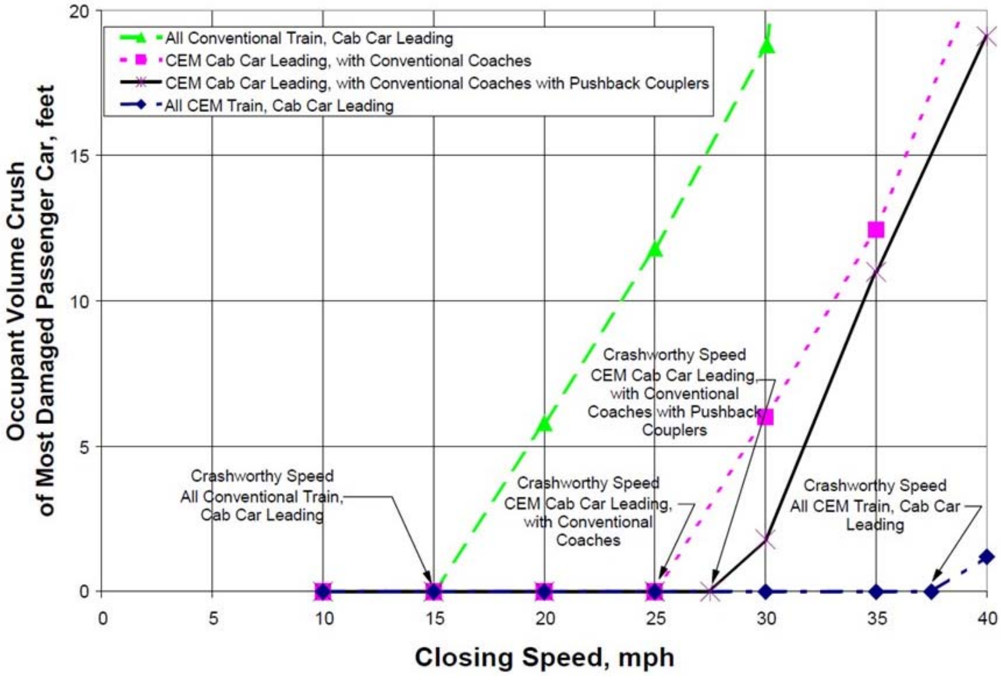


Figure 2.2 – Plot of Crush vs. Closing Speed for Various Train Types, Including Conventional Trains (from Tyrell and Tsai, 2006)

2.10 Talgo Document, Compliance of the Talgo Trainsets with the Rules Proposed by the Federal Railroad Administration for Tier I Trains (49 CFR Part 238), Volumes 1-3 (1 October 1998), see also Docket No. FRA-1999-6404-0043 through 0045

This document includes substantial information about the characteristics of the Talgo Series VI carbody, including crashworthiness characteristics. For purposes of the present report, we note that it includes the following:

- Section 4. "The structure of the trainsets presently under production is designed to meet the requirements of Section 566 of the rules and regulations of the Union Internationale des Chemins de Fer (hereinafter referred to as "UIC"), which, amongst others, require a static end strength (also knows and referred to as "buff strength") of 441,000 pounds. Compliance with this standard is shown through finite element analysis of the intermediated car (see, appendix 2): end service car (see, appendix 3); and, end baggage car (see, appendix 4). One of the baggage cars which forms part of the consist presently under construction was tested statically. The test results demonstrate that the design complies fully with UIC 566. The testing protocol and report of said test are included in appendix 6."

2.11 Talgo Document, Side Impact Strength (1 October 1998)

This document provides a value for the sum of the section moduli about the weak axis, the longitudinal axis of the carbody, of 21.4 cu in. The required value is 6.8 cu in. The value about the strong axis, the transverse axis of the carbody, is much greater and also satisfies the CFR requirement.

2.12 Talgo Document, Modification of the Weight-Bearing Bars Mechanism (6 March 2000)

This report provides details on the dimensions and material properties of the weight bearer bars and their connecting hardware. The detailed dimensions and properties are included in Section 4.2 of this report.

2.13 Talgo Document, Safety Straps and Weight-Bearing Bars (27 March 2000)

This report provides details on the safety straps that are part of the truck-to-carbody attachment. The results show that a safety strap in the basket configuration (wrapped around a component) has a rated strength of 5,000 kg (11 kips) with a safety factor of 7, meaning the actual breaking strength (the ultimate strength) of the two straps together is 35,000 kg (77 kips). The report also provides additional details of the weight bearer bar system connection hardware.

2.14 Talgo Document, CA-0624, Guiding Rods Calculation (F065) (1 July 2015)

This report provides dimensions and material properties of the guide rods (steering guides) and their connecting hardware. The detailed dimensions and properties are included in Section 4.7 of this report.

2.15 Talgo Drawings

We utilized Talgo Series VI drawings for some of our calculations. We reviewed several drawings, and we cite the specific drawings used in our crashworthiness analysis (Section 4).

2.16 Talgo Final Submission Report to the NTSB (12 April 2019), 64 pages

This report includes some dimensions and material properties of the vehicle components that we use in our calculations (Section 4).

2.17 Steel Construction Manual, American Institute of Steel Construction, 15th Edition

This manual includes the Specification for Structural Steel Buildings, 360-16, which we used to calculate the buckling strength of some of the components. The manual is based upon the load and resistance factor design (LRFD) approach. In this approach, the actual strength of components is calculated and factors on both load and resistance (strength) are applied to account for the variability and uncertainty of these effects. The equations for strength are generally applicable to engineering structures and components, not just buildings.

2.18 Aluminum Association, "Aluminum Design Manual, Specification for Aluminum Structures, Part I," 2015

We used this design manual to evaluate the strength of the corner post structure.

2.19 ASTM A283-03, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

This standard includes steel made by the open hearth process. Grade A has a minimum yield strength of 24 ksi.

3. DESCRIPTION OF THE TALGO SERIES VI CARBODY AND CONNECTIONS

We derived the information in this section from the documents we reviewed (Section 2 of this report) and through discussions with Talgo engineers.

The Talgo Series VI carbody is fabricated by welding together aluminum extrusions and plates. Figure 3.1 shows an illustration of the carbody. The length of a passenger car is 43 ft, with a typical weight of 31,000 lbs. The truck weight is 5,900 lbs. Car ends are supported by a truck located between the cars. One end, the supported end, is supported directly by the truck towers, while the adjacent end, the suspended end, is supported by weight bearer bars, the top points of which are connected to the supported end, as shown in Figure 3.2. The pivot axes at the ends of a weight bearer bar are perpendicular to each other.

There is a longitudinal connection between car ends through an articulated component, shown in Figure 3.3, which permits some degree of pitch, yaw, and roll for one car end relative to the other. Each end of this connection is bolted to the carbody structure. The connection at the center consists of a heavy coupling shaft with components that permit the pitch, yaw, and roll motions.

The trucks are connected longitudinally to the carbodies by four steering guides, two for each carbody end and two for each side, illustrated in Figure 3.4. The pivot axes at the ends of a steering guide are perpendicular to each other. The trucks are also attached to the carbody ends through six straps and two cables, shown schematically in Figure 3.5. These same attachments contribute to the lateral strength between the truck and the carbody. Figure 3.6 shows an end view of the truck, and Figure 3.7 shows lateral stops on the articulated connection that restrict lateral movement of the truck.

Details of these components are provided in the Talgo documents reviewed in Section 2 of this report, and we describe many of them in our crashworthiness assessment below.

The Talgo Series VI cars are in train consists that have a locomotive or locomotive-like cab car (Amtrak NPCU) and an unoccupied vehicle at each end, with the passenger cars between these vehicles. The locomotive on one end of the consist includes a CEM system on both its lead and trailing ends.

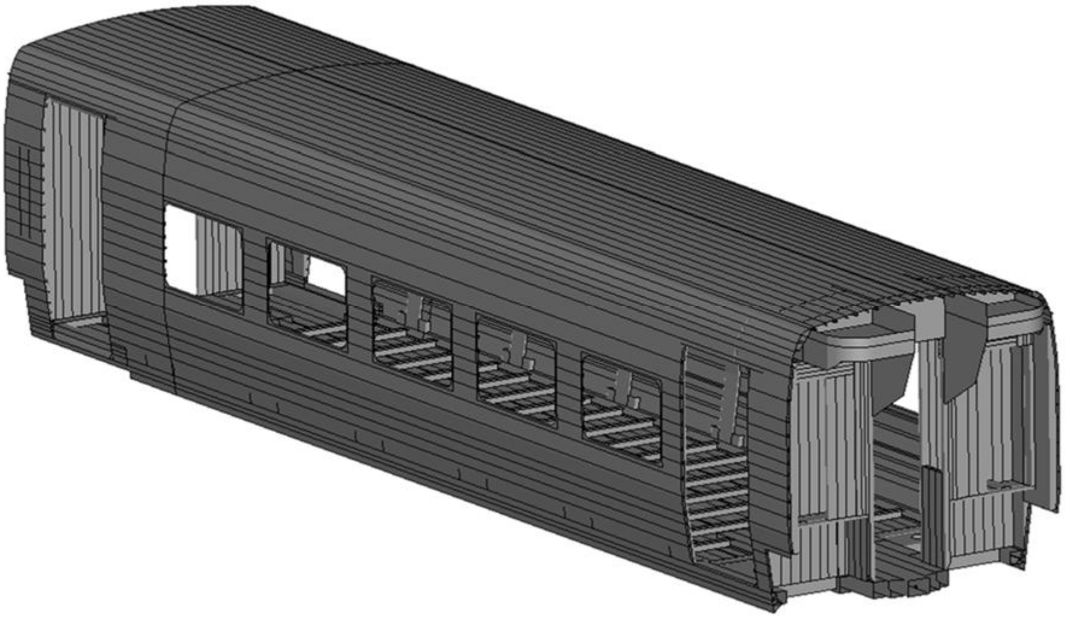
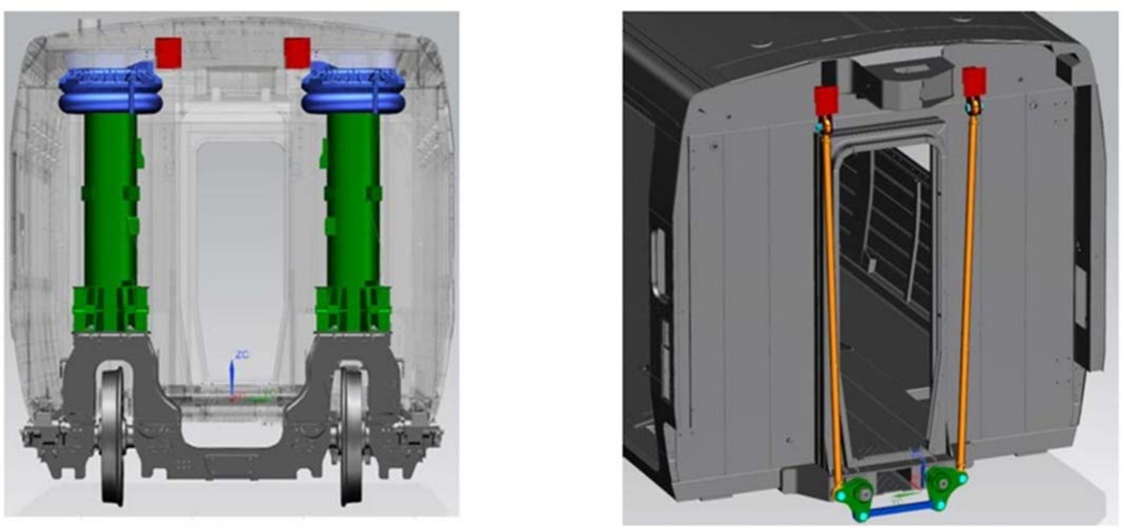


Figure 3.1 – Illustration of the Talgo Series VI Carbody



Supported end   Suspended end

Figure 3.2 – Illustrations of the Supported and Suspended Ends of the Talgo Series VI Cars

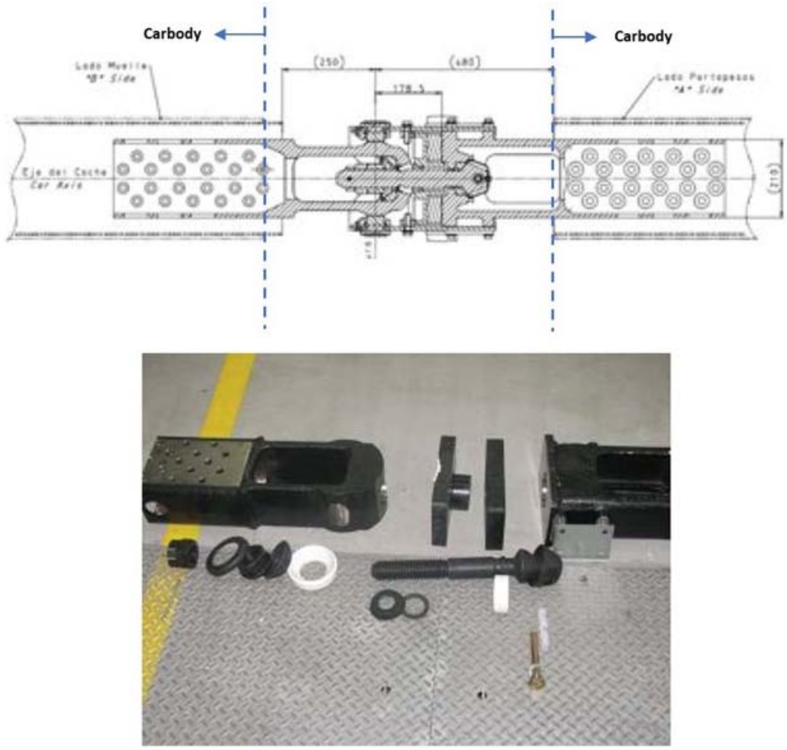


Figure 3.3 – Schematic and Photo of the Articulated Connection between Talgo Series VI Coupled Cars

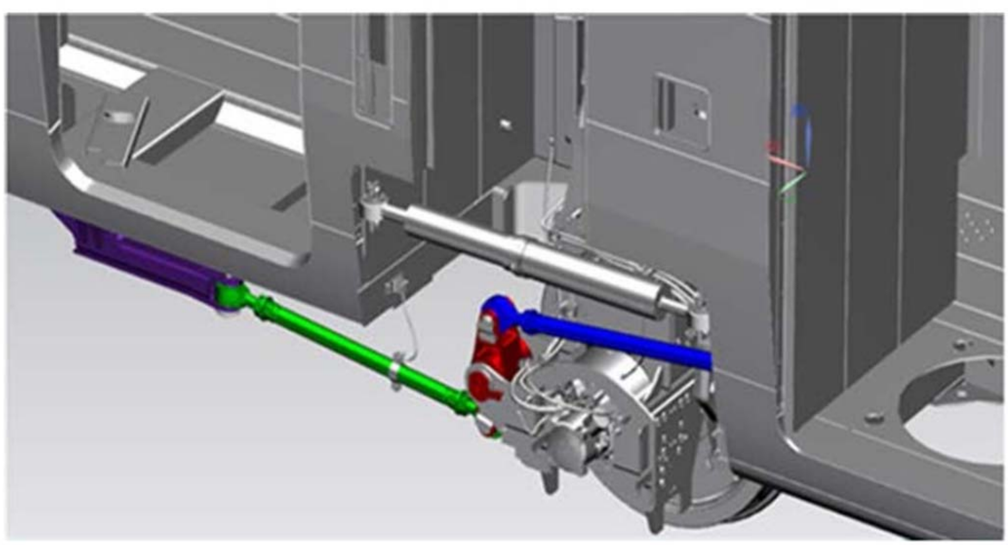


Figure 3.4 – Schematic of the Steering Guides Between Talgo Series VI Car Ends (green and blue components)

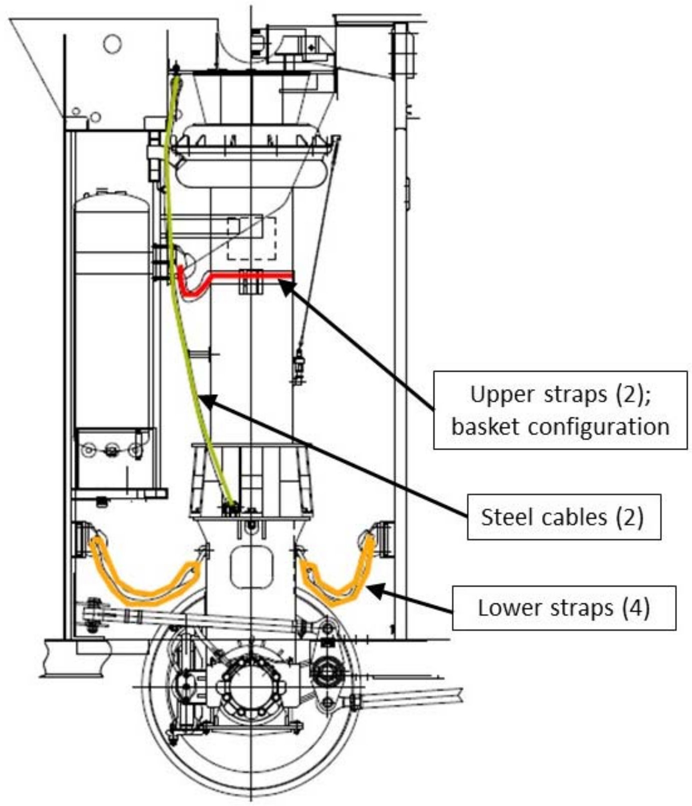


Figure 3.5 – Side View Showing Truck-to-Carbody Attachment Straps and Cables

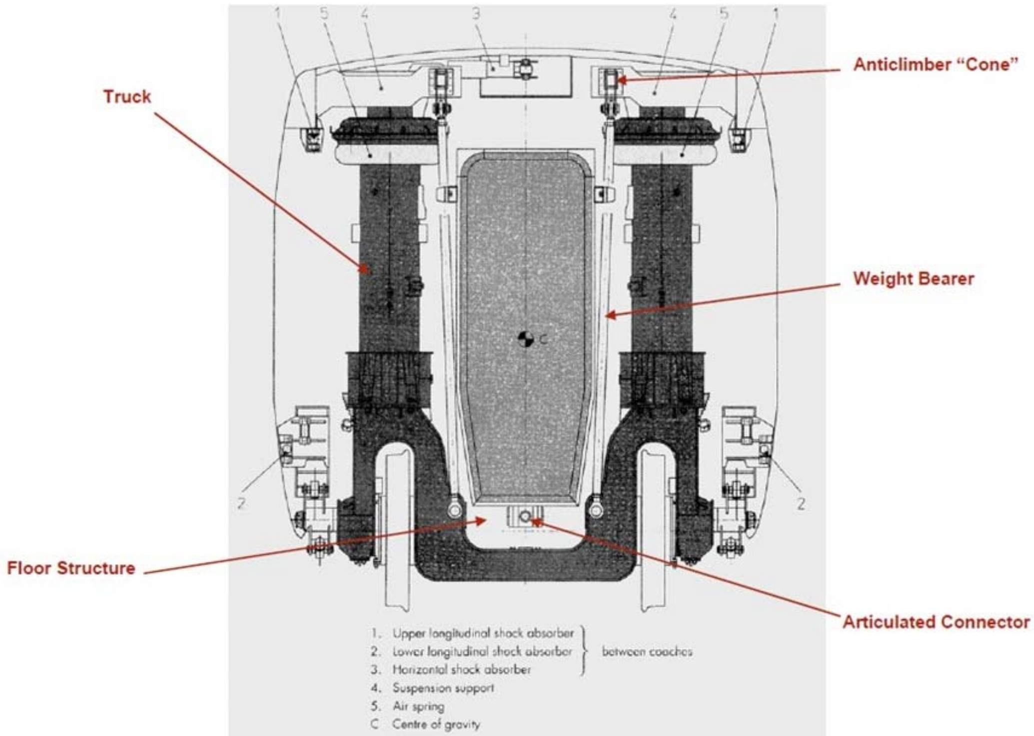


Figure 3.6 – End View of Truck

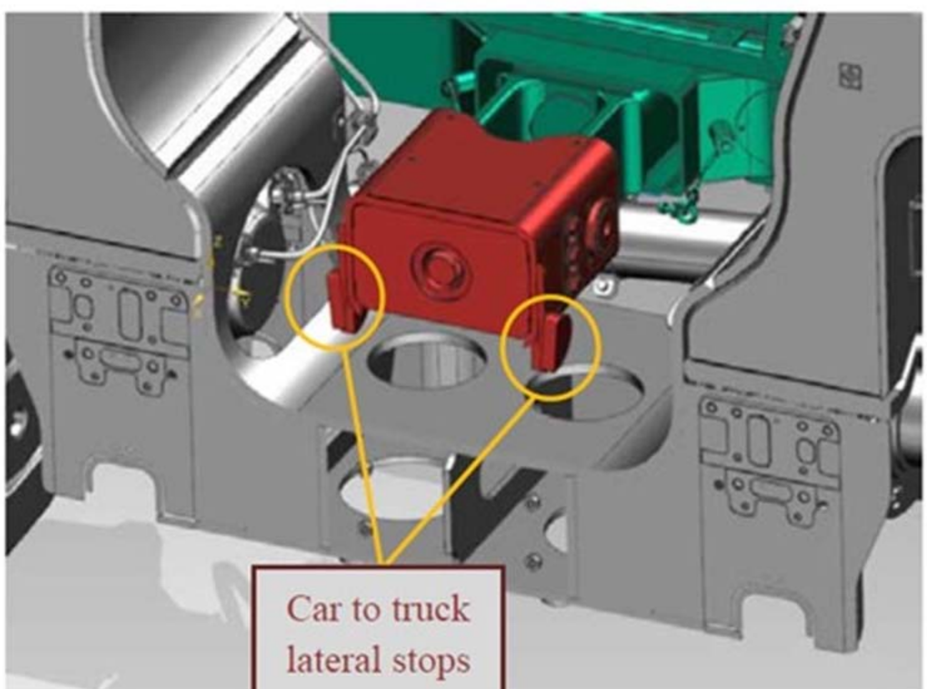


Figure 3.7 – Truck Lateral Stops on the Articulated Connection

4. ANALYSIS OF TALGO SERIES VI TRAINSETS CRASHWORTHINESS

In this section we conduct calculations and review information to determine the extent to which the Talgo Series VI carbody meets current CFR regulations with respect to crashworthiness. Each section includes a description of the regulations (in some cases paraphrased for brevity), a summary of the results of the evaluation, and the details of the evaluation.

4.1 Static End Strength, 49 CFR §238.203, §238.703

49 CFR 238 Appendix G allows one to demonstrate occupant volume strength, also referred to as static end strength, for Tier I cars in passenger trainsets by meeting the conventional requirements of §238.203 or the Tier III passenger trainset requirements of §238.703 and §238.705.

4.1.1 Evaluation of Quasi-Static Compression Load Requirements, 49 CFR §238.703

4.1.1.1 Regulations

49 CFR §238.703 requires that a carbody shall resist a minimum quasi-static end load applied on the collision load path of:

> (i) 800,000 pounds without permanent deformation of the occupied volume; or
> (ii) 1,000,000 pounds without exceeding either of the following two conditions:
>> (A) Local plastic strains no greater than 5 percent; and
>> (B) Vehicle shortening no greater than 1 percent over any 15-foot length of the occupied volume; or
>
> (iii) 1,200,000 pounds without crippling the body structure. Crippling of the carbody structure is defined as reaching the maximum point on the load-versus-displacement characteristic.

4.1.1.2 Results

Figure 4.1 shows the load vs. displacement plot from our finite element analysis along with three horizontal lines corresponding to the loads from conditions (i), (ii), and (iii) listed above. This plot shows that the carbody reaches a maximum load (cripples) at 1,283,000 lbs, which is greater than the required crippling load from condition (iii). Figure 4.2 shows the calculated deformation at 1,200,000 lbs.

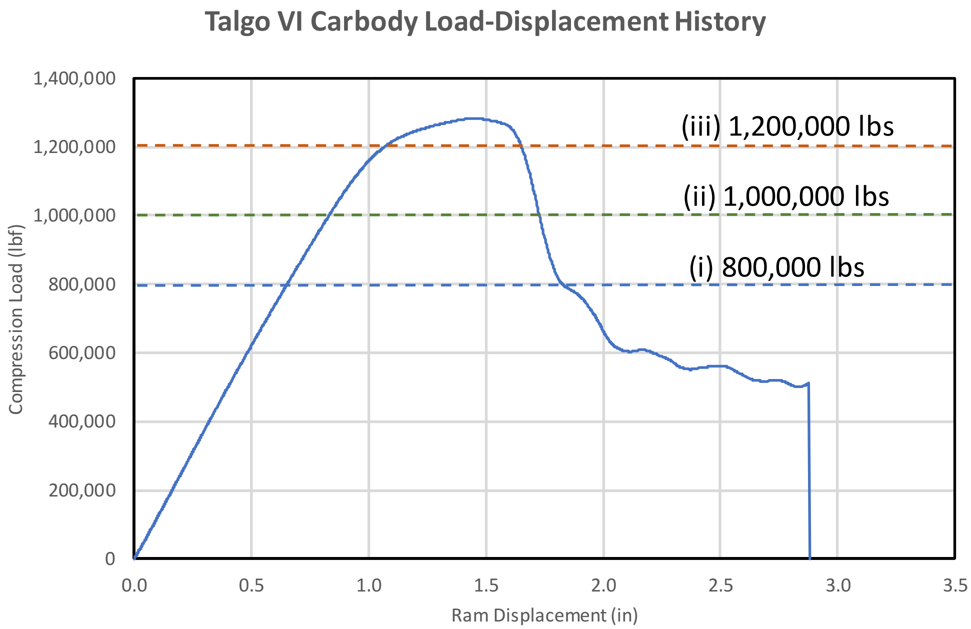


Figure 4.1 – Load vs. Displacement Plot from Quasi-Static Compression Analysis of Talgo Series VI Carbody

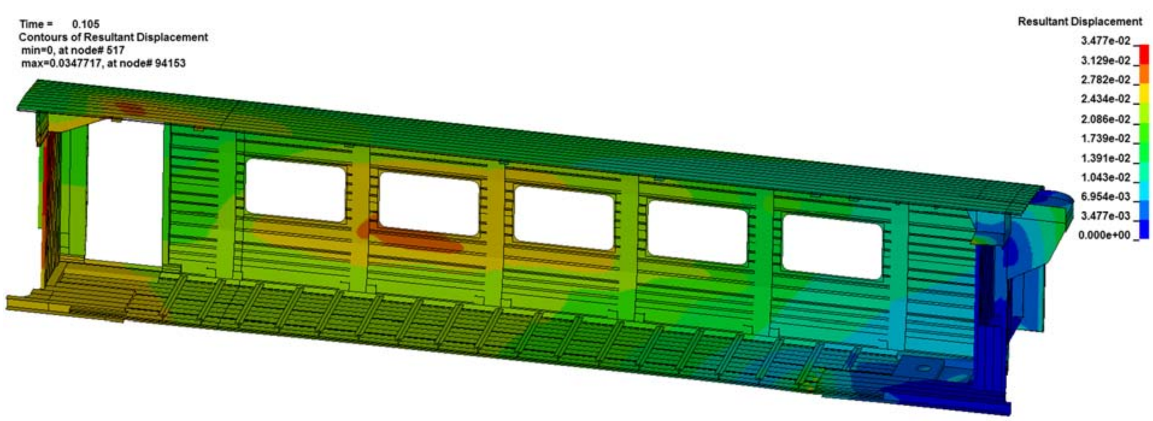


Figure 4.2 –Displacement Contours at 1,200,000 lbs Compression Load for the Talgo Series VI Carbody; Contours from 0 to 0.03477 m (0 to 1.4 in)

4.1.1.3 Evaluation

We conducted a finite element analysis using the explicit finite element analysis program LS-DYNA to determine whether the Talgo Series VI carbody meets conditions (i), (ii), or (iii) above. We followed the general methodology described in the FRA report, DOT/FRA/ORD-11/22. We began with the partial carbody model used in the ADL study, which we obtained from TIAX (the former technical group of ADL). We used Talgo-provided drawings listed in Table 4.1 to complete a model of the entire carbody structure.

Table 4.1 – Talgo Series VI Carbody Structural Drawings Used to Build the Finite Element Model

Level	Component	Description	Reference	Quantity
1	781005	COACH CAR LAYOUT	T41.0008 C	1
1	781182	COACH CAR	T41.0200.01 A	5
2	781572	BODYSHELL STRUCTURE	T41.0136.03 D	1
3	781148	LEFT SIDE	T41.0101 B	1
3	781149	RIGHT SIDE	T41.0102 B	1
3	781154	FRAME	T41.0103 -	1
3	781166	CEILING	T41.0104 A	1

The resulting model, shown in Figure 4.3, consists of 827,179 elements and 789,952 nodes. The model is made entirely of shell elements with a uniform mesh. The characteristic element length is 20 mm. The uniformly meshed carbody is illustrated in Figure 4.4. We used the same material properties as used in the ADL study for the carbody construction material, 6005A T6 aluminum. Table 4.2 and Figure 4.5 summarize the properties.

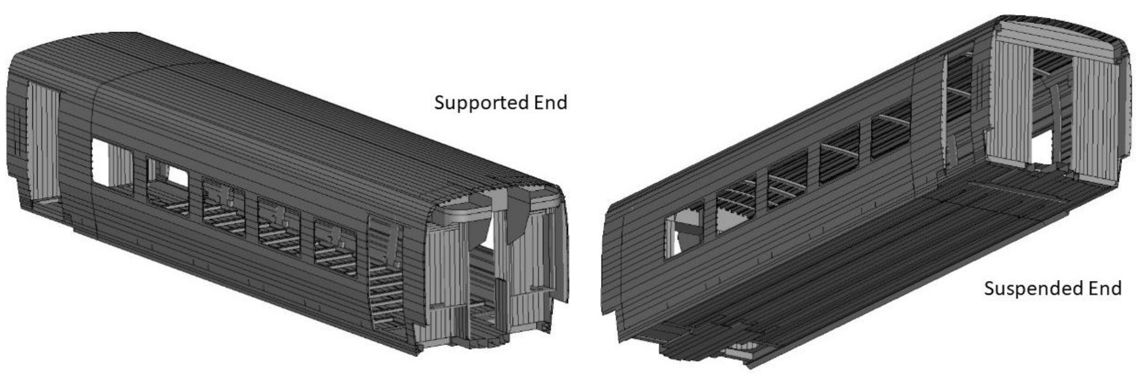


Figure 4.3 – LS-DYNA Finite Element Model of Talgo Series VI Carbody

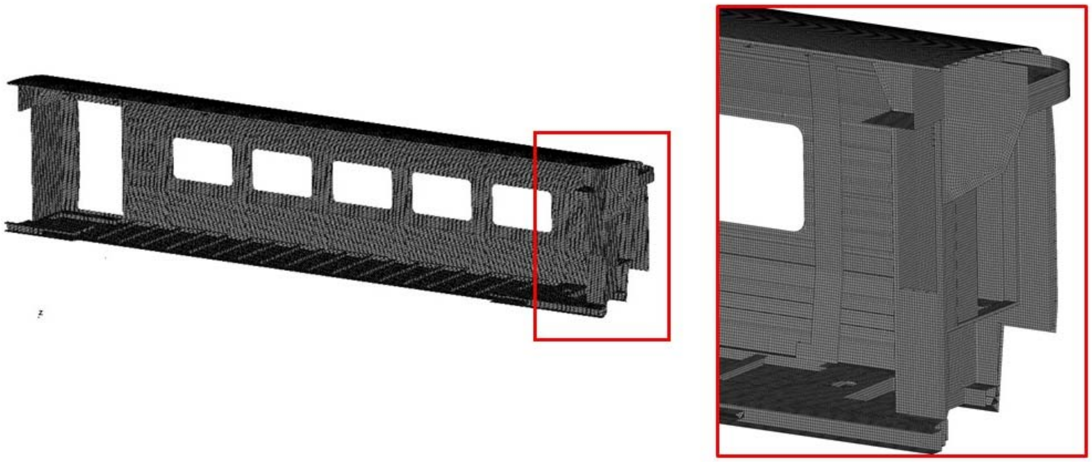


Figure 4.4 – Finite Element Model Mesh Detail

Table 4.2 – Material Properties of 6005A T6 Aluminum

Property	Value	Unit
Yield Stress	235	MPa
Young's Modulus	69	GPa
Poisson's Ratio	0.33	
Density	2,700	kg/m^3

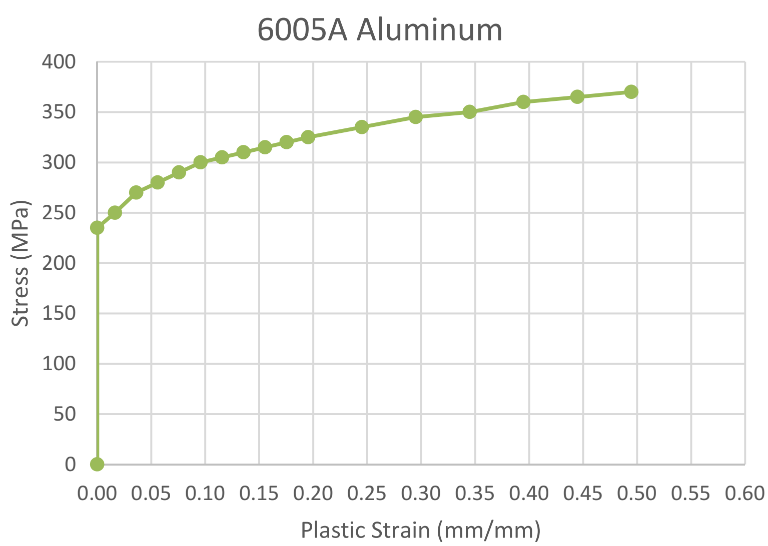


Figure 4.5 –True Stress vs. True Plastic Strain Curve Used in LS-DYNA Analysis

We applied a prescribed displacement history to the suspended end through rigid blocks over areas to represent the collision load path and we constrained the corresponding areas through blocks at the supported end. The areas are (Figure 4.6):

- Two areas corresponding to the end wall inboard of the truck supports. Each area is equal to 14.6 x 26.8 in.^{2} (370 x 680 mm^2).
- An area equal to 52.5 x 83.1 in.^{2} (1,333 x 2,110 mm^2), corresponding to the area covered by the truck frame.
- The articulated connector.

For the fixed (constrained) area blocks, longitudinal motion is constrained through contact between the carbody structure and the blocks (Figure 4.7). The constraint at the articulated connector is applied through a constrained nodal rigid body (CNRB), which rigidly connects the nodes shown in the figure. A central node is used to control the motion of the overall CNRB. In this model, the CNRB on the supported end is fully fixed—no linear or rotational motion is permitted at the CNRB nodes. We applied a prescribed velocity condition on the same areas but at the suspended end, as shown in Figure 4.8. We used the normalized curve shown in Figure 4.9 to apply the velocity in the longitudinal direction. With this curve, we increased the velocity slowly and smoothly to produce a quasi-static loading history with minimal dynamic response. The steady state velocity magnitude was 0.5 m/sec (1.6 ft/sec).

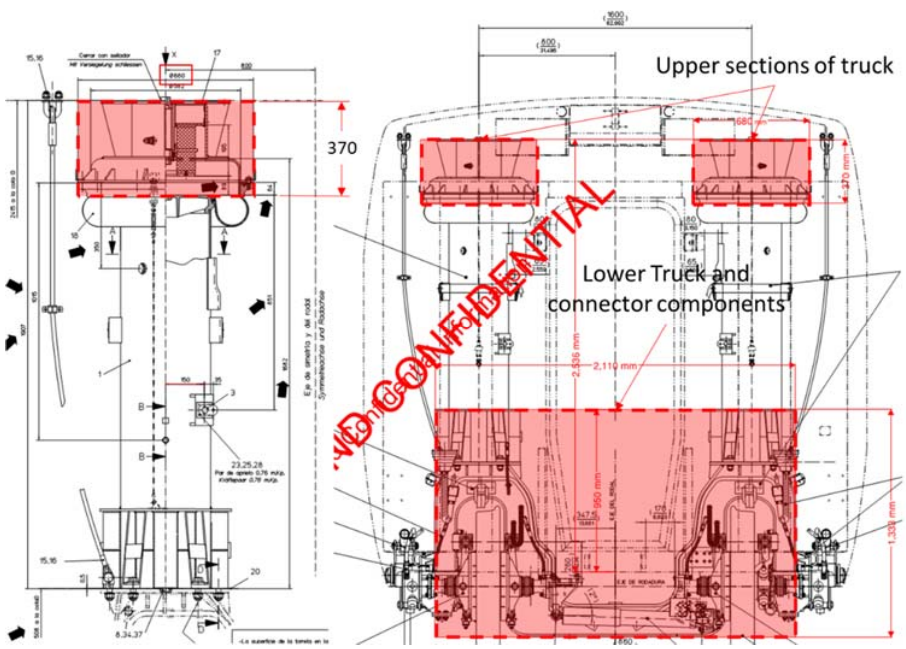
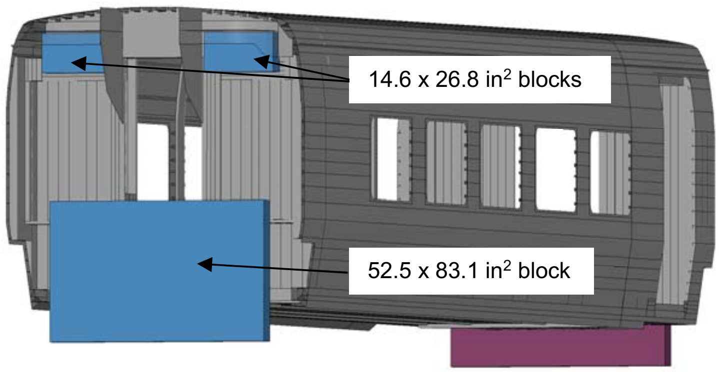
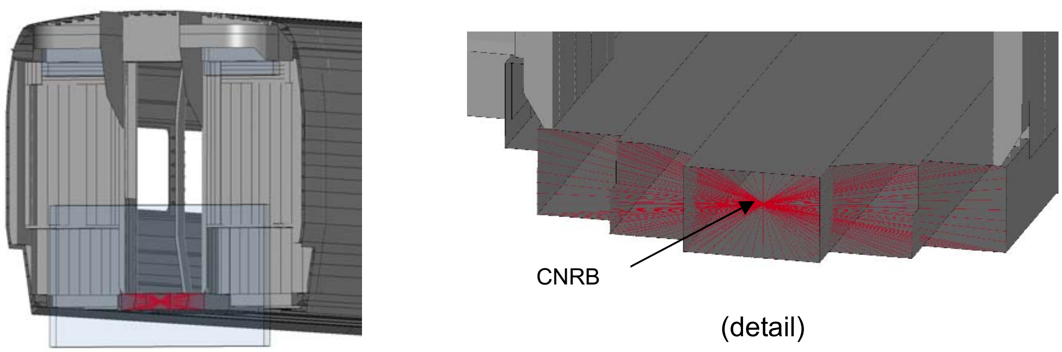


Figure 4.6 – Loaded End Wall Areas in the Occupant Volume Strength Analysis



a. Constraining blocks on supported end



b. Constraint at supported end articulated connection anchor

Figure 4.7 – Supported End Boundary Constraints Applied to LS-DYNA Model

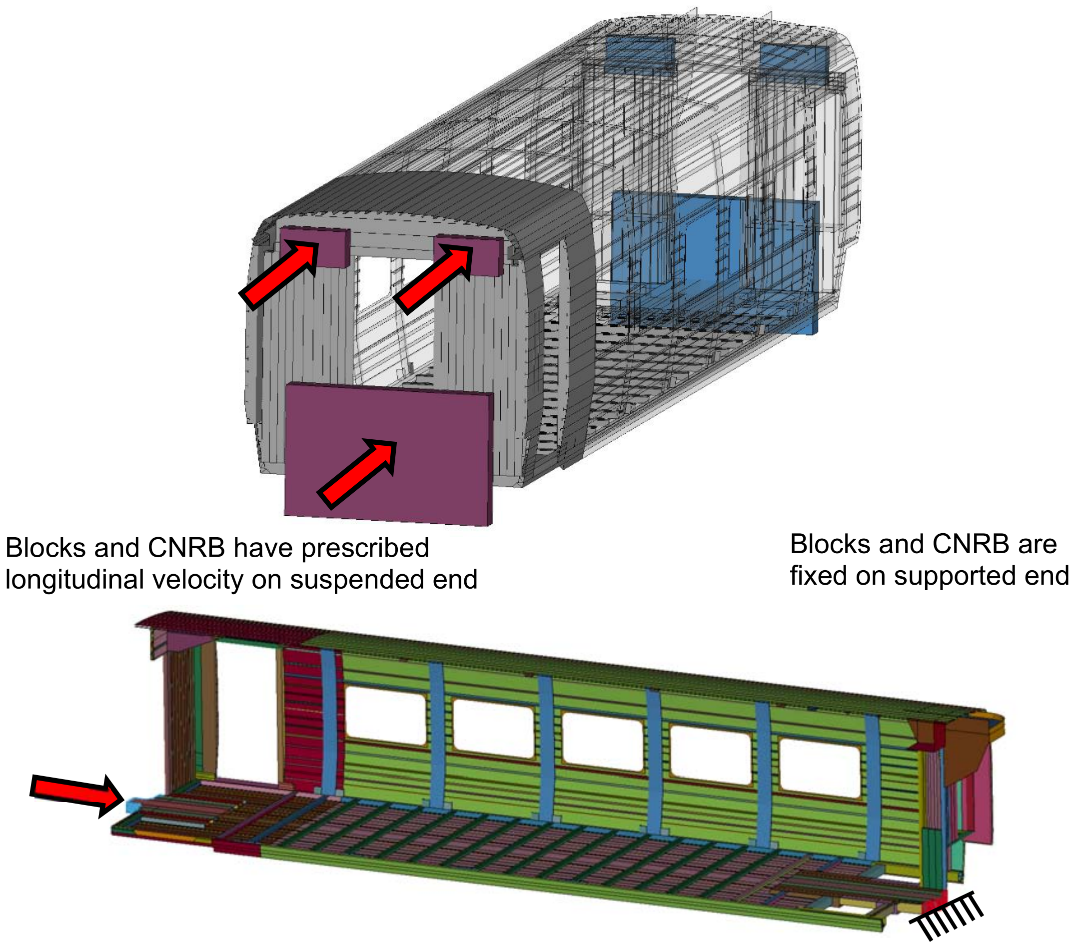


Figure 4.8 – Suspended End Wall Loading Methodology

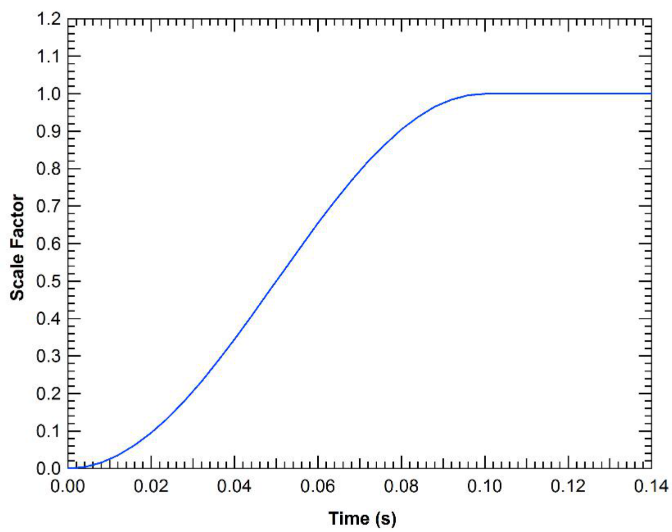


Figure 4.9 – Normalized Quasi-Static Velocity Application Profile

We applied mass scaling to allow the calculation to proceed at a reasonable pace. The selected mass scaled timestep was 1.5 microseconds (μs). This is substantially smaller than the Courant condition for stress wave propagation requires: $\Delta t \leq 6.7$ μs based on the nominal 20 mm element size used in the model and a minimum sound speed through processed aluminum of 3 mm/μs. Mass scaling added a total of 4.1 kg, which is 0.1% of the 3,290 kg carbody model mass. The added mass was applied to a small number of elements, which would otherwise require a smaller timestep. The calculation timestep is also within the LS-DYNA recommended maximum time step for contact stability (1.73 μs for this model).

Figure 4.10 shows plots of internal energy and kinetic energy vs. time. The kinetic energy is less than 5% of the internal energy, including when the carbody cripples and kinetic energy is maximum, which shows that the calculation is quasi-static (see Section 4.4.2 of DOT/FRA/ORD-11/22). The resulting load-displacement curve and the deformed shape at 1,200 kips are shown in Figures 4.1 and 4.2, respectively.

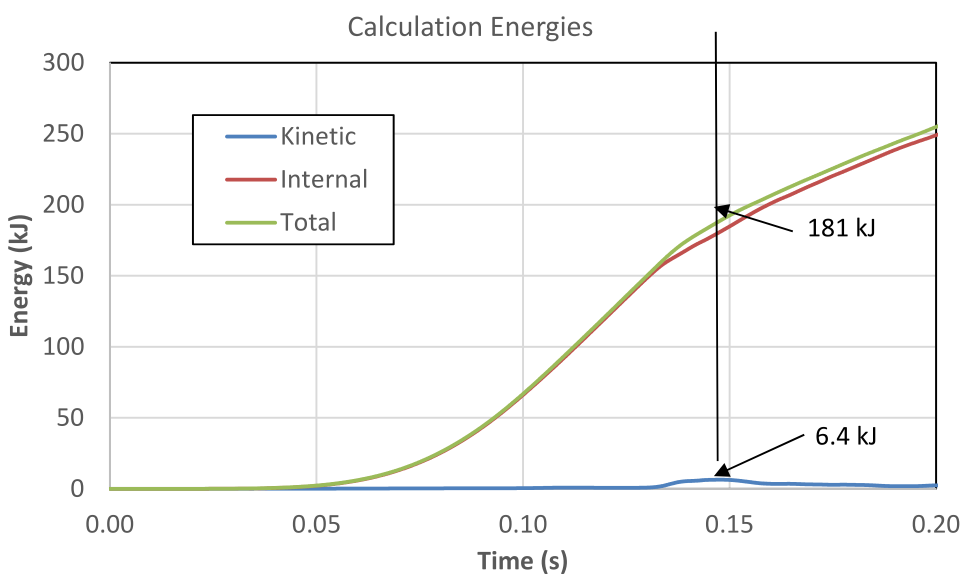


Figure 4.10 – Calculation Energy Shows that the Simulation is Quasi-Static (6.4 kJ Kinetic /181 kJ Internal = 3.5% at Point of Peak Kinetic Energy)

4.1.2 Evaluation of the Dynamic Collision Requirements of 49 CFR §238.705

4.1.2.1 Regulations

For the dynamic collision scenario specified in 49 CFR §238.705, which consists of the subject trainset (in this case the Talgo Series VI trainset) colliding with the FRA-defined, locomotive leading conventional train at 25 mph, each car in a trainset must meet one of the following conditions:

i) There shall be no more than 10 in. of longitudinal permanent deformation; or

ii) Global vehicle shortening shall not exceed 1% over any 15 ft length of occupied volume.

4.1.2.2 Results

The permanent deformation at each Talgo Series VI carbody end for three collision scenarios is less than 10 in., Figure 4.11. The collision scenarios are:

A. Front impact of the Talgo VI trainset with the configuration given in the NTSB report

B. Front impact of the Talgo VI trainset with the "typical" configuration

C. Reverse impact of the Talgo VI trainset with the "typical" configuration

The maximum deceleration of a simulated Talgo VI car mass in this simulation is 21 g. This is used in evaluation of the truck-to-carbody attachment strength, Section 4.7.

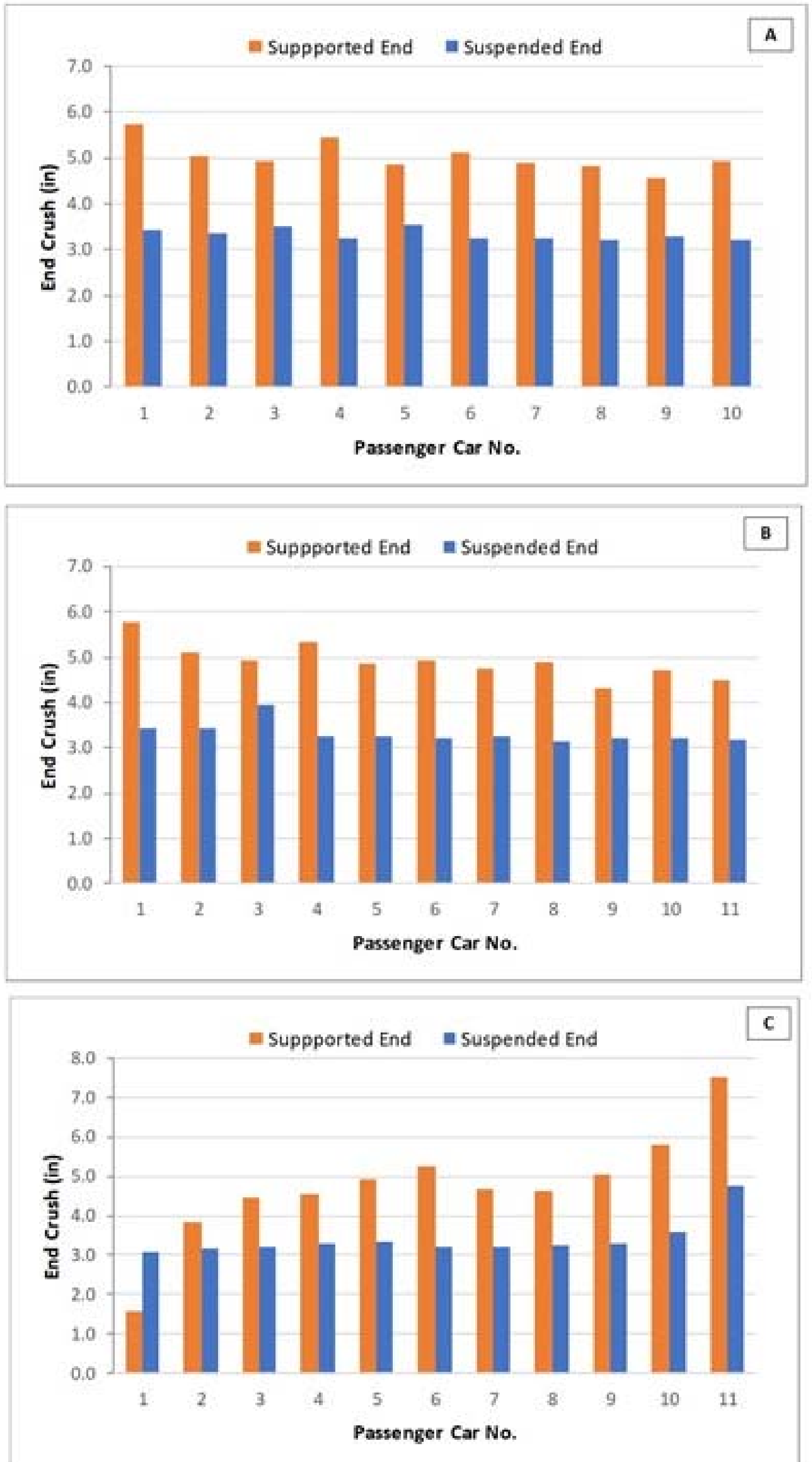


Figure 4.11 – Summary of Talgo Series VI Carbody End Crush Results for Three Collision Scenarios

4.1.2.3 Evaluation

We conducted one-dimensional collision dynamics analyses to determine whether the Talgo Series VI carbody meets conditions (i) or (ii) from 49 CFR §238.705. We followed the general methodology described in the FRA report, DOT/FRA/ORD-11/22. We did not conduct three-dimensional analysis because the consist incorporating the Talgo Series VI cars has relatively rigid locomotives on each end; there is no three-dimensional interaction between the FRA-defined locomotive and a Talgo Series VI car as there is for the case when a passenger-containing car impacts the FRA-defined locomotive. For this analysis, we considered the following three collision scenarios, each of which is for a collision into the conventional CFR-defined trainset:

A. Front impact of the Talgo Series VI trainset having the configuration given in the NTSB report

B. Front impact of the Talgo Series VI trainset having the “typical” configuration

C. Reverse impact of the Talgo Series VI trainset having the “typical” configuration

The typical configuration has one more passenger car than the configuration given in the NTSB report. We used a model we developed in Abaqus Explicit in which each car is represented by a point mass with a nonlinear spring on each end (such a model is also known as a lumped mass model). We did not model the individual truck separately; it is included as part of each car. The nonlinear spring represents a draft gear element, when a draft gear is present, and an element to simulate the non-recoverable load-crush response of the carbody end to which it is attached. The load-crush responses we used for the Talgo VI carbody ends are shown in Figure 2.1. We used the CEM locomotive crush response from Llana, et.al. 2013 (see Section 2.7). We used the load-crush response from the CFR for the cars in the FRA-defined train. We obtained the mass for each Talgo train car from discussions with Talgo and for the FRA-defined train from the CFR. We assigned an initial velocity of 25 mph to the Talgo train; the FRA-defined train was initially stationary. We did not include braking friction. Figure 4.12 shows a schematic diagram of the simulated locomotives and cars near the front impact point (locomotive-to-locomotive). All collision scenarios are in accordance with the requirements of 49 CFR §238.705.

The crush results of the simulations are shown in Figure 4.11. The maximum acceleration of a simulated Talgo VI car mass in this simulation is 21 g.

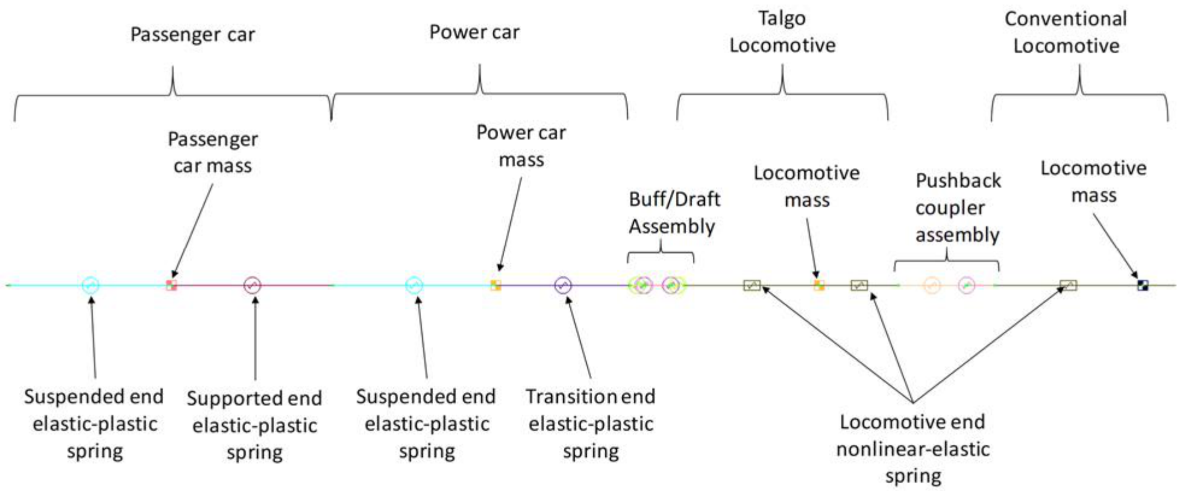


Figure 4.12 – Diagram of Simulated Vehicles in the One-Dimensional Collision Dynamics Model Near the Front Impact Point

4.2 Anticlimbing, 49 CFR §238.205

4.2.1 Regulation

§238.205 requires an anticlimbing mechanism capable of a vertical yield strength of 100,000 lbs for both upward and downward movement of one coupled end relative to the adjacent end.

4.2.2 Results

The total minimum vertical strength occurs when the suspended end moves upward relative to the supported end (weight bearers in compression) and is:

- Weight bearer bars (two) buckling strength = 155 kips
- Articulated connector yield strength = 82.1 kips
- Total = 155 + 82.1 kips = 237 kips > 100 kips.

4.2.3 Evaluation

The components providing primary vertical strength at the coupled interface between Talgo Series VI cars are the weight bearer bars and the articulated connector (Section 3). The weight bearer bars are placed in tension when the supported end moves upward relative to the suspended end, and they are placed in compression when the suspended end moves upward relative to the supported end. The articulated connector is subjected to shear for both directions of movement. We provide calculations here for the most important structural members contributing to the strength. We have also evaluated the strength of the connections in the load path of these members and find them to be greater than the primary members. We have not included the details of those calculations here for brevity and proprietary reasons but we can provide them on request.

4.2.3.1 Vertical Strength of Weight-Bearer Bars and Their Connections

The components in the load path of the weight bearer bar system are (Figure 3.2): the connections at the top of the car, the weight bearer bars, the bell crank and its connections, and the lower connecting rod.

The axial load that causes yielding in a weight bearer bar for tension or compression is:

$$P_y = (\sigma_Y)\left[\frac{\pi}{4}\left({D_o}^2 - {D_i}^2\right)\right]$$

where σ_Y is the material yield strength (355 MPa, 51.5 ksi) and D_o (63.5 mm, 2.5 in.) and D_i (43.5 mm, 1.7 in.) are the outer and inner diameter, respectively of the tubular bar cross section.

$$P_y = (355)\left[\frac{\pi}{4}(63.5^2 - 43.5^2)\right] = 597\ kN(134\ kips)$$

Buckling must be checked to determine the axial load a weight bearer bar can sustain in compression. We use the methods provided in the AISC Manual of Steel Construction, Specification 360-16, Section E3 to calculate buckling strength. Buckling strength is given by:

$$P_{cr} = F_{cr}A$$

where P_{cr} is the critical buckling load, F_{cr} is the critical buckling stress, and A is the member cross-sectional area. The formula used for F_{cr} depends upon the slenderness ratio, KL/r:

$$\frac{KL}{r} < 4.71\left[\frac{E}{\sigma_y}\right]^{\frac{1}{2}},\ F_{cr} = \left(0.658^{\frac{\sigma_y}{F_e}}\right)\sigma_y$$

$$\frac{KL}{r} > 4.71\left[\frac{E}{\sigma_y}\right]^{\frac{1}{2}},\ F_{cr} = 0.877F_e$$

$$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$$

where E = elastic modulus (29x10^6 psi), σ_y = material yield strength, L = member length, and r = radius of gyration of the cross-section. K = a factor to account for how each end is fixed: it is equal to 1.0 when the member can freely rotate about each end (as is the case for the lower connecting rod of the weight bearer bar system) and is equal to 0.7 when one end is free to rotate but fixed at the other end (as is the case for the weight bearer bars since the end axes of rotation are perpendicular to each other.)

For a weight bearer bar, L = 2.34 m (92.1 in.), and r = = 19.2 mm (0.76 in.) These values provide a critical buckling load for one weight bearer bar of 77.5 kips. The tension or compression yield load of the lower connecting rod is 95.8 kips and the connecting rod buckling load is 81.6 kips. The buckling load controls the strength when the weight bearer bar is in compression (when the suspended end is moved upward relative to the supported end.)

- From these values we determine that the anticlimbing strength of the weight-bearer bar system is: 2(77.5) = 155 kips (the controlling case is when the suspended end moves upward relative to the supported end.)

4.2.3.2 Vertical Strength of the Articulated Connector (Coupler)

We evaluated the strength of the articulated connector for its resistance to anticlimbing. We obtained component information from the Talgo reports and drawings described in Section 2 of this report. The connector includes several components to achieve its various functions. The spherical joint permits pitch, yaw, and roll between coupled car ends. The overall connector also provides longitudinal, vertical, and lateral strength. Figure 4.13 shows the configuration of these components when a vertical load is applied to one side with respect to the other side.

The coupling shaft – the blue component in Figure 4.13 – has a minimum diameter of 39.4 mm (1.55 in.) and a maximum diameter of 50 mm (1.97 in.). It is made from 34CrMo4 quenched and tempered steel and has a yield strength of 500 MPa (72.5 ksi) and a tensile strength of 750 MPa (109 ksi). This gives minimum shear yield and shear ultimate strengths of 82.1 kips and 123 kips, respectively.

The coupling shaft is subjected to bending under the action of a vertical load as shown in Figure 4.13, resulting in contact between internal components at several locations. It is difficult to define a yield load because local contact will cause local yielding in several locations. Instead, we calculate the vertical load to cause plastic bending of the coupler shaft. We used the average of the yield and tensile strength for this calculation and obtained a strength of 98.4 kips.

The rectangular cross section elements of the articulated connection on each side of the spherical joint (Figure 4.14) have the following characteristics:

- Suspended end: height = 145 mm (5.7 in.), thickness = 26 mm (1.0 in.)
- Supported end: height = 109 mm (4.3 in.), thickness = 11 mm (0.43 in.)

There are two such rectangular sections for each side. The material tensile yield and ultimate strengths of these elements are 490 MPa (71 ksi) and 735 MPa (107 ksi), respectively. The strength of the supported end elements is lower than the suspended end elements. The yield and ultimate shear strengths of the supported end elements are 158 kips and 237 kips, respectively.

The shear yield strength is governed by the yield strength of the pin and is equal to 82.1 kips.

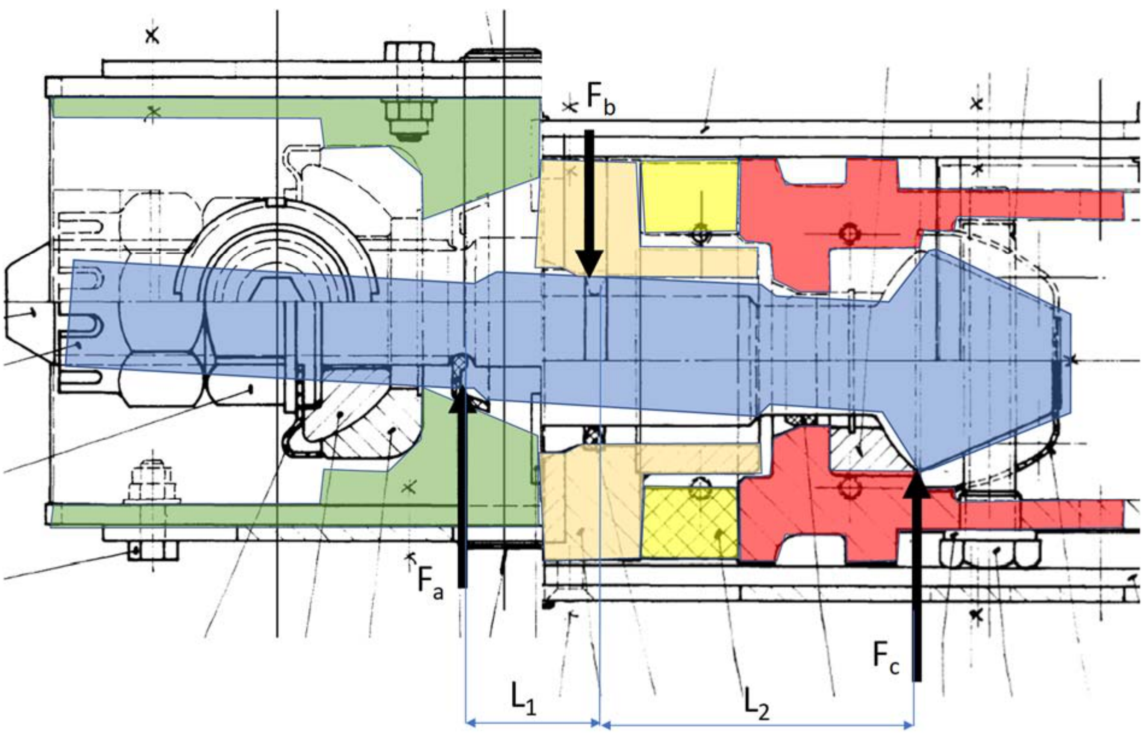


Figure 4.13 – The Coupler Subjected to Three-Point Bending Due to Vertical Differential Displacement at the Articulated Connection

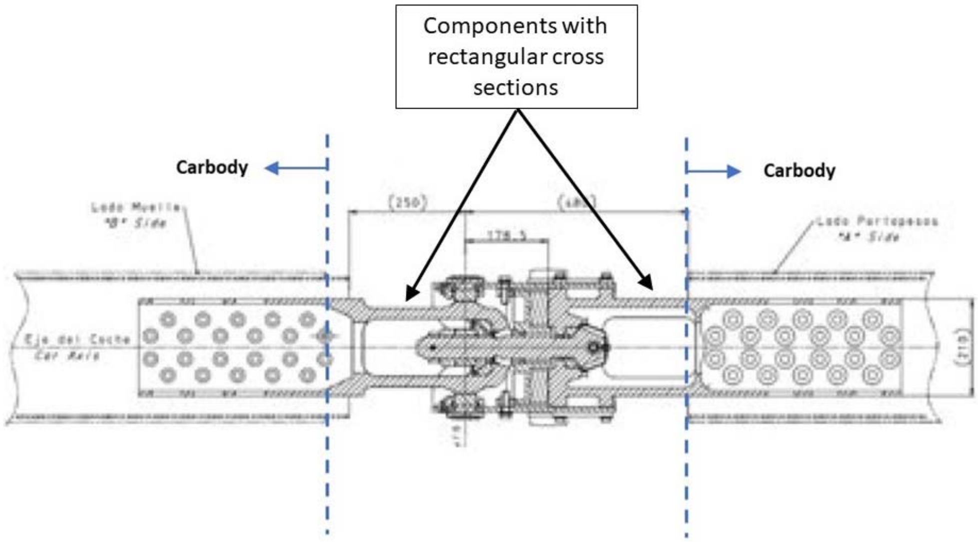


Figure 4.14 – The Articulated Connection Showing the Components with Rectangular Cross-Sections

4.3 Collision Posts, 49 CFR §238.211.

4.3.1 Regulation

The end structure requirements of this section (§238.211) apply only to the ends of a semi-permanently coupled consist of articulated units, provided that the railroad submits to FRA under the procedures specified in §238.21 a documented engineering analysis establishing that the articulated connection is capable of preventing disengagement and telescoping to the same extent as equipment satisfying the anti-climbing and collision post requirements contained in this subpart; and FRA finds the analysis persuasive.

4.3.2 Results

The Talgo Series VI trains are semi-permanently coupled. The end cars of the Series VI trainsets have collision posts. Section 4.2 of this report shows that the articulated connection has anticlimbing strength that exceeds the regulations. In addition, having the trucks located between car ends at the articulated connections provides a measure of protection against telescoping (when one car end overrides and penetrates the other car end) because car ends would contact and be resisted by the truck frame and truck pillars (Figures 3.2 and 3.5).

4.4 Corner Posts, 49 CFR §238.213

4.4.1 Regulation

Each passenger car shall have at each end of the car, placed ahead of the occupied volume, two full-height corner posts, each capable of resisting together with its supporting carbody structure 150,000 lbs base ultimate shear strength; 20,000 lbs ultimate strength at the roof; 30,000 lbs yield strength applied at 18 in. above the top of the underframe.

4.4.2 Results

The structure at the corners of the Talgo Series VI cars meet the CFR requirements except for one case:

- Base ultimate shear strength: minimum strength = 177 kips > 150 kips
- Roof ultimate strength: minimum strength = 21 kips > 20 kips
- Yield strength at 18 in. above top of underframe:
  - At all corners except the supported end on the side with the HVAC opening: minimum = 49 kips > 30 kips
  - At the supported end only in the longitudinal direction on the side with the HVAC opening: minimum strength = 21 kips < 30 kips

4.4.3 Evaluation

The Talgo Series VI cars do not have isolated corner posts as cars of conventional design do. In our experience this is common for cars of aluminum extrusion construction. We have considered equivalent corner structure in our evaluation with the knowledge that structural energy absorption is the important parameter in collisions; the strength requirement of CFR §238.213 is an approximate measure of energy absorption capacity. We only considered structure within approximately 8 in. of the end wall for longitudinal loading and approximately 30 in. from the side for transverse loading. We only considered enough material within these distances to show the underframe and roof shear strength requirements are met. Figure 4.15 shows the corner cross sections at the underframe level. The calculation for shear strength of the base and roof connections is the product of the cross-sectional area of the elements and the ultimate shear strength of the aluminum in the heat-affected zone (HAZ). The ultimate tension strength of the HAZ is 165 MPa (23.9 ksi). We used an ultimate shear strength of the HAZ equal to 0.6 times the tensile strength, or 14.4 ksi. We calculated the yield strength at 18 in. by using bending theory in which the connections at the underframe and roof levels are fixed. We used the moment of inertia of the elements and the yield strength of the base metal, 216 MPa (31.3 ksi) for these bending calculations. The results of the calculations are shown in Tables 4.3 through 4.5. The only case in which the strength does not meet the CFR §238.213 requirement is for permanent deformation due to a 30 kip load applied 18 in. above the top of the underframe on the supported end in the longitudinal direction. This only occurs on the supported end side with a heating, ventilation, and air conditioning (HVAC) door (the side without a door meets the requirement due to the additional length of side wall).

Table 4.3 – Ultimate Strength of Corner Structures at the Top of the Underframe

Location	Longitudinal (kips)	Transverse (kips)
Suspended End	185	234
Supported End	177	177

Table 4.4 – Force Applied 18 in. Above the Top of the Underframe Required to Cause Permanent Deformation of the Corner Structure

Location	Longitudinal (kips)	Transverse (kips)
Suspended End	95	49
Supported End	21	76

Table 4.5 – Ultimate Strength of Corner Structures at the Connection to the Roof

Location	Longitudinal (kips)	Transverse (kips)
Suspended End	21	28
Supported End	21	24

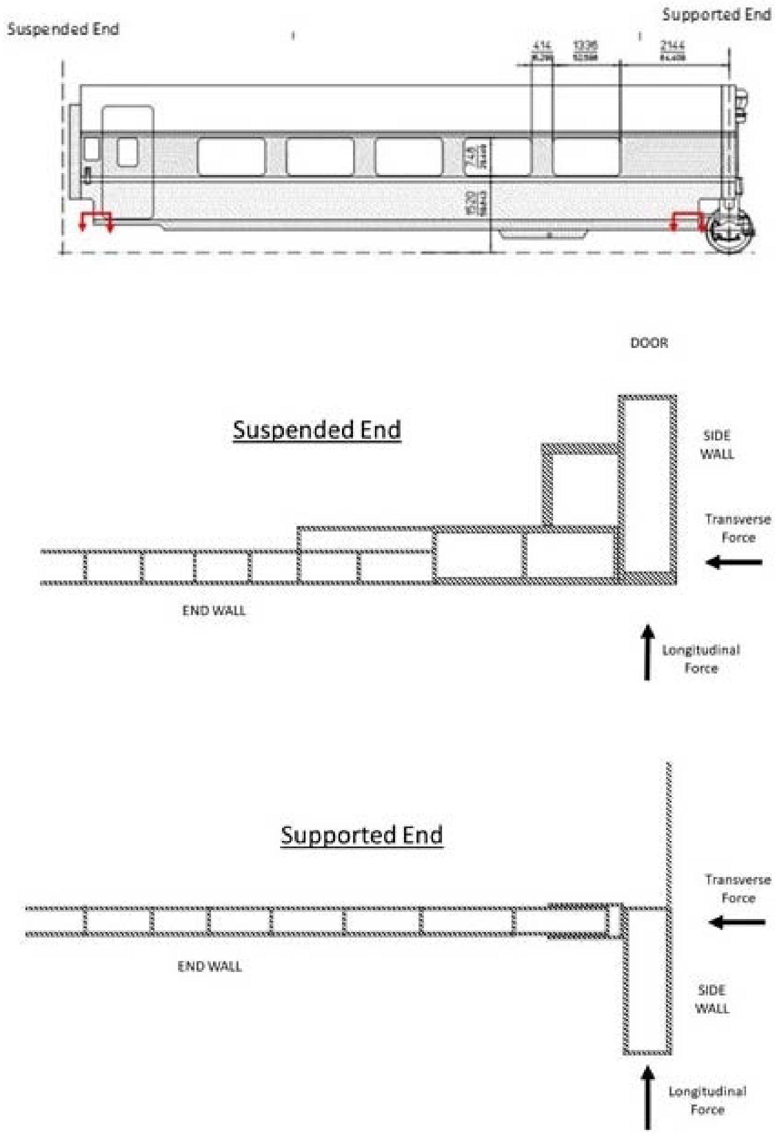


Figure 4.15 – Underframe Corner Structures Considered in Strength Evaluation

4.5 Rollover Strength, 49 CFR §238.215

4.5.1 Regulation

For a car resting on its side or roof, stresses shall be less than one-half the yield strength and one-half the critical buckling stress.

4.5.2 Results

Our finite element analysis calculations show that the stresses are less than one-half the yield strength and one-half the buckling stress for rollover on both the side and on the roof.

4.5.3 Evaluation

We used the finite element model described in Section 4.1.1 to assess the carbody rollover strength compared to 49 CFR §238.215. The regulation requires investigation of two scenarios: one with the carbody resting on its side, supported at the side and cant rail, and one resting on its roof, supported by both cant rails. The model setup for both scenarios is shown in Figure 4.16 below.

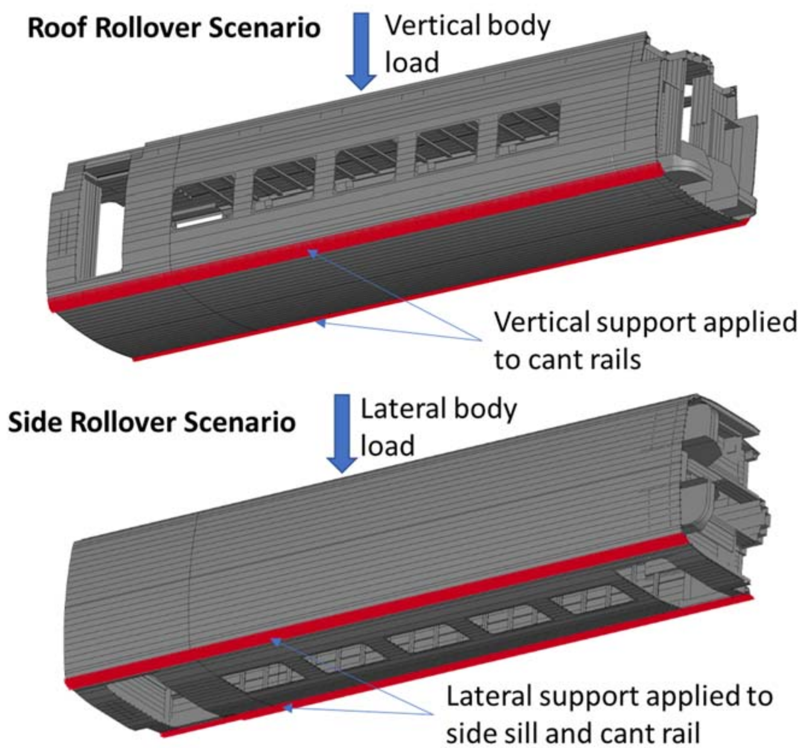


Figure 4.16 – Rollover Strength Assessment Model Loads and Boundary Conditions

We analyzed the buckling tendency directly with the explicit nonlinear model by doubling the applied gravity load. If the model shows no sign of buckling at this load, we can conclude that the critical buckling threshold is satisfied. Assuming stresses have not exceeded yield with twice the load, that criterion is satisfied as well.

To optimize the load initialization process, we used a combination of instantaneously applied gravity and global damping to minimize dynamics and to simulate a resting condition. We ran short dynamic test calculations to determine appropriate damping constants for the system in both the side and roof supported configurations. Ideally, the damping constant should result in near critical damping. The reaction load histories measured at the supports for both scenarios are provided in Figure 4.17, which shows that both simulations quickly converged on the expected full load.

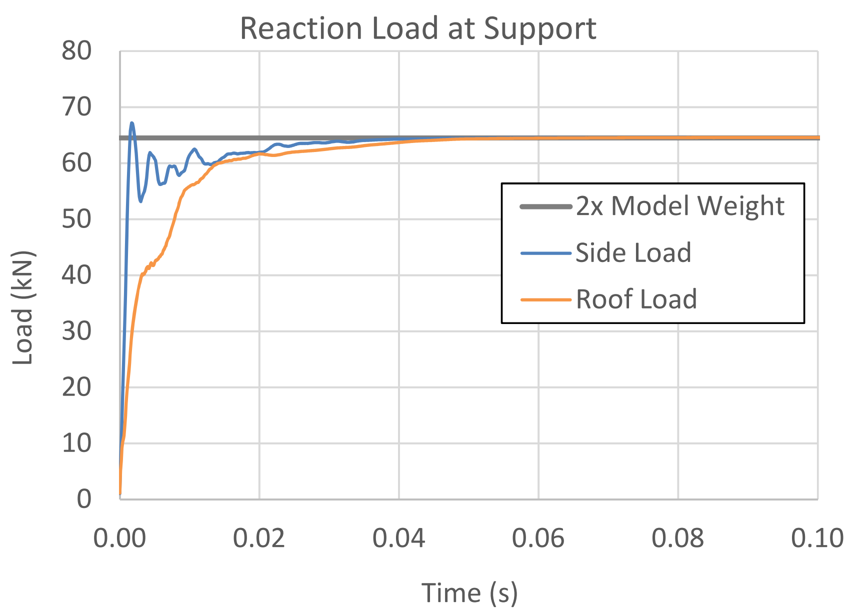
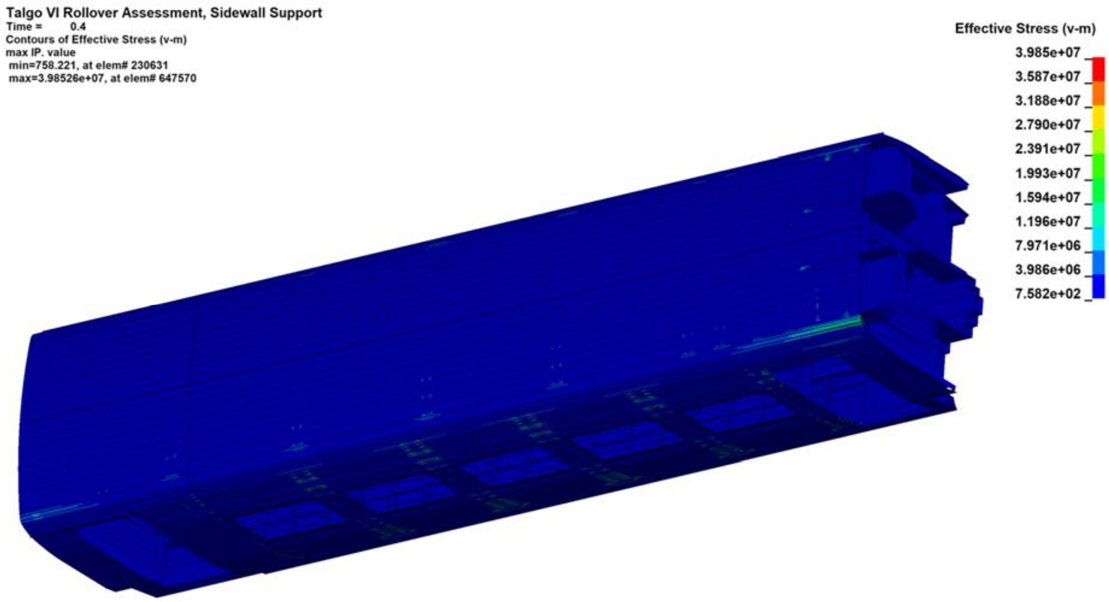
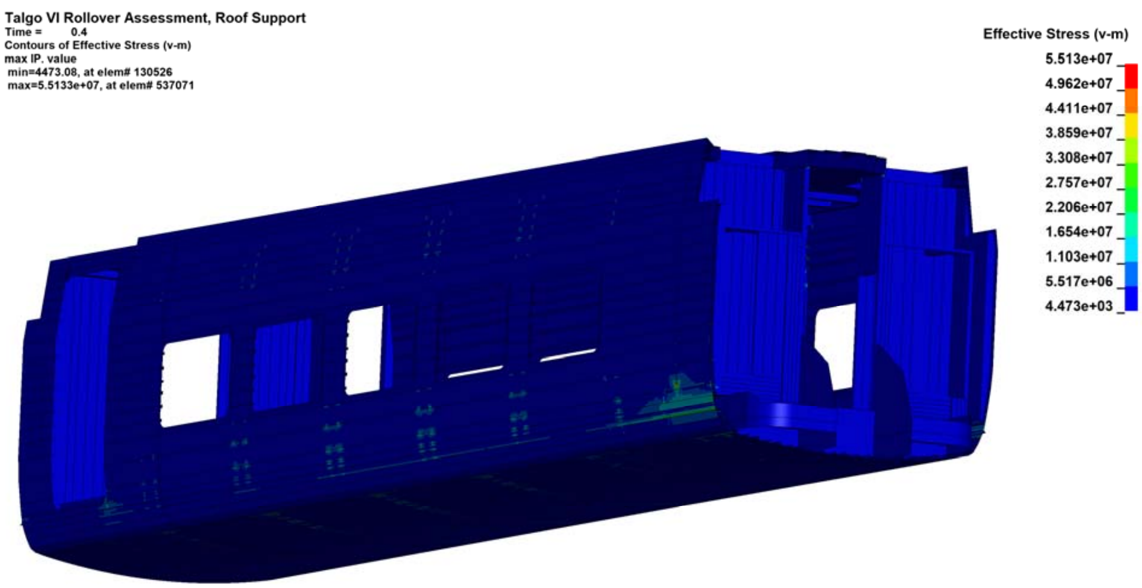


Figure 4.17 – Reaction Loads Illustrating Static Load Convergence

Contours of carbody von Mises stresses under static equilibrium for both scenarios are shown in Figure 4.18. Plastic strain contours, shown in Figure 4.19, illustrate that the entire carbody remains below yield for both load configurations; there is no plastic strain. Resultant displacement contours are shown in Figure 4.20.

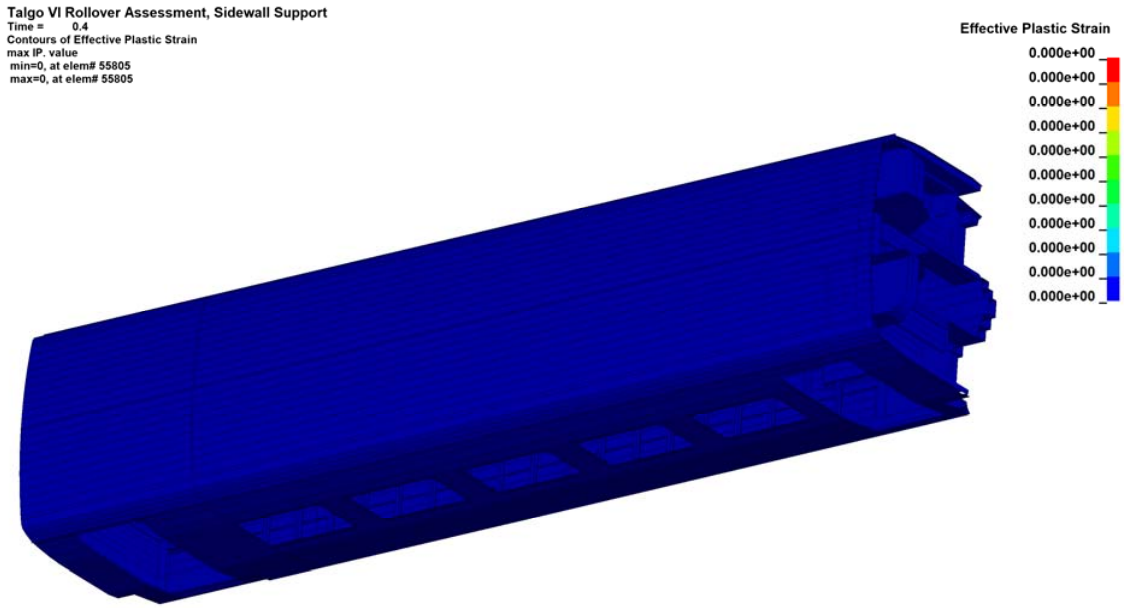


a) Side loading (Maximum stress: 40 MPa (5.8 ksi))

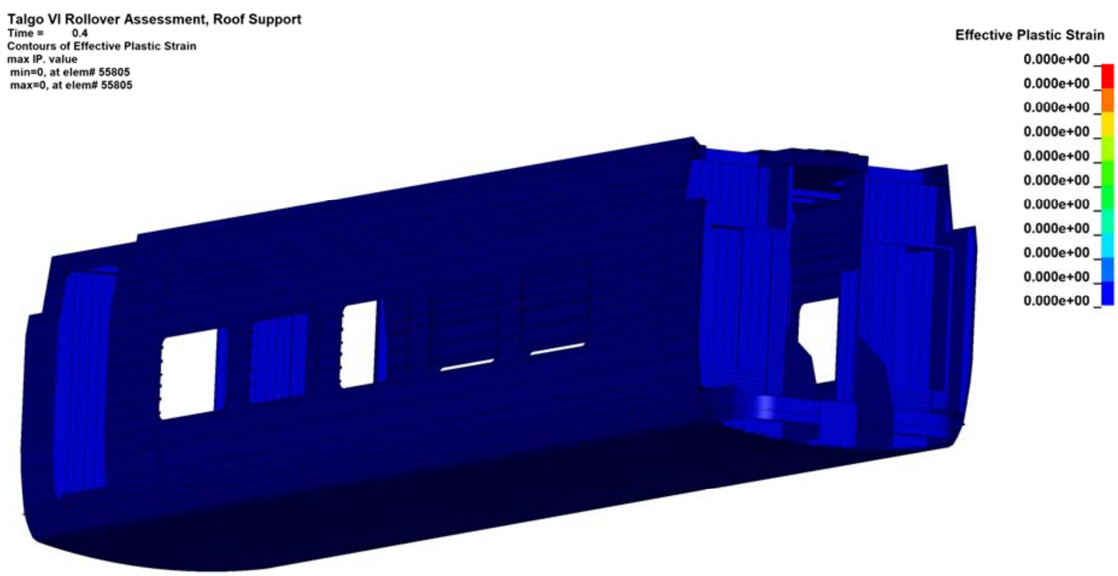


b) Roof loading (Maximum stress: 55 MPa (8.0 ksi))

Figure 4.18 – Rollover Analysis Scenarios, Resultant Stress

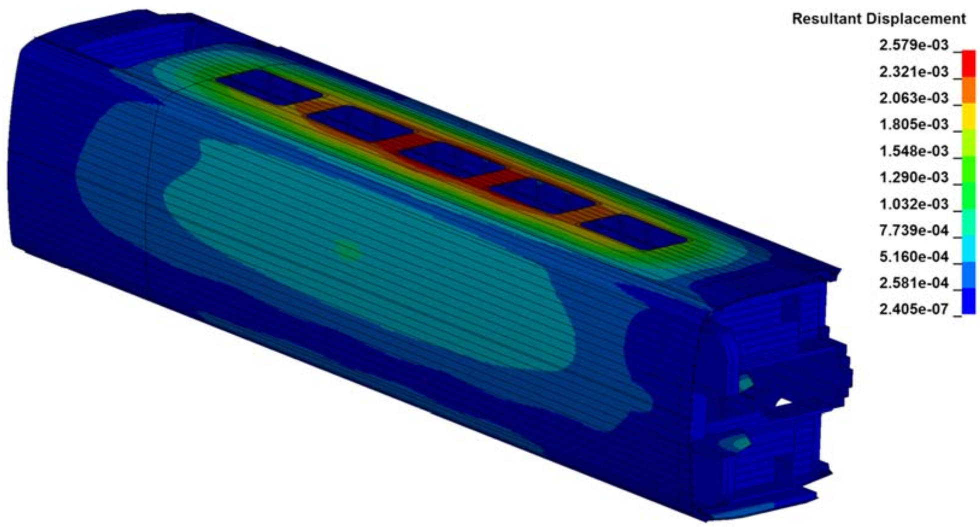


a) Side loading (no plasticity)

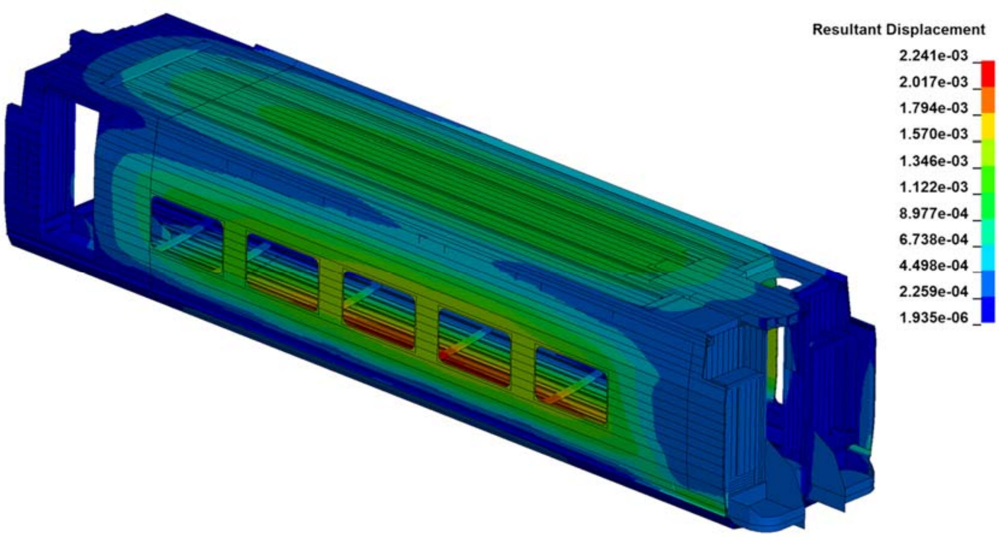


b) Roof loading (no plasticity)

Figure 4.19 – Rollover Analysis Scenarios, Plastic Strain



a) Side loading (Maximum displacement: 2.6 mm (0.10 in.))



b) Roof loading (Maximum displacement: 2.2 mm (0.09 in.))

Figure 4.20 – Rollover Analysis Scenarios, Resultant Displacement

4.6 Side Strength, 49 CFR §238.215

4.6.1 Regulation

The sum of the section moduli in cubic inches—about a longitudinal axis, taken at the weakest horizontal section between the side sill and side plate—of all posts and braces on each side of the car located between the body corner posts shall be not less than 0.30 multiplied by the distance in feet between the centers of end panels. The sum of the section moduli in cubic inches—about a transverse axis, taken at the weakest horizontal section between the side sill and side plate—of all posts, braces and pier panels, to the extent available, on each side of the car located between body corner posts shall be not less than 0.20 multiplied by the distance in feet between the centers of end panels. Outside sheathing of mild, open-hearth steel when used flat, without reinforcement (other than side posts) in a side frame of modified girder or semi-monocoque construction shall not be less than 1/8 in. nominal thickness. Other metals may be used of thickness in inverse proportion to their yield strengths.

4.6.2 Results

We reviewed the report by Talgo (Section 2.11) and find their calculations to be correct with respect to section moduli; that is, the regulation is satisfied. The "skin" of the car, part of the aluminum extrusion, is 3 mm (0.118 in.) thick with a strength of 215 MPa (31 ksi). The product of these two numbers exceeds the CFR sheathing requirement (the equivalent of 0.125 in. thick of open hearth steel, which can have a strength of 24 ksi.)

- (0.118)(31) = 3.66 > (0.125)(24) = 3.00

4.7 Truck-to-Carbody Attachment, §238.219, §238.717

4.7.1 Regulation

> §238.219. Resist without failure (ultimate strength) the individually applied loads: 2g vertically on the mass of the truck; and 250,000 pounds in any horizontal direction on the truck, or:
>
> §238.717 (alternative compliance) Resist without yielding the individually applied loads, 3g vertically downward; 1g laterally; 5g longitudinally provided the average longitudinal deceleration at the CG of the equipment during the impact does not exceed 5g; and the peak longitudinal deceleration of the truck during the impact does not exceed 10g for the dynamic collision scenario, or (instead of the 5g longitudinal requirement) the truck shall be shown to remain attached after a dynamic impact under the conditions in the collision scenario.

4.7.2 Results

The results for our evaluation according to §238.219 are:

- Longitudinal ultimate strength = 497 kips > 250 kips
- Lateral ultimate strength = 471 kips > 250 kips
- Vertical ultimate strength > 308 kips > 11.8 kips (2g)

The results for our evaluation according to §238.717 are:

- Longitudinal ultimate strength = 497 kips > 124 kips (21g from collision scenario)

- Lateral ultimate strength = 471 kips > 5.9 kips (1g)
- Vertical ultimate strength > 308 kips > 17.7 kips (3g)

4.7.3 Evaluation

Each Talgo Series VI truck is attached by several components to the supported end and the suspended end of the cars between which the truck is positioned (Figures 3.4 and 3.5). The components providing truck-to-carbody attachment strength are the steering guides, straps, and cables. There are four steering guides per truck: two guides attach to the supported end and two attach to the suspended end. There are two steel cables attaching the truck to the supported end. There are six high-strength fabric securement straps, four attaching the truck to the supported end and two attaching the truck to the suspended end. Resistance to separation in the lateral direction is provided by the articulated connection, the car sides (which extend beyond the car ends) and the components listed above.

4.7.3.1 Steering Guide Longitudinal Strength

We calculate the ultimate longitudinal strength provided by the steering guide system as the strength for the connection to the supported end. If the truck is displaced longitudinally away from the supported end, the lower steering guide bars would be placed in compression and they would eventually buckle, causing the crank component to rotate. Load would then be carried by the two upper steering guides in tension.

The outer diameter of the steering guide rod section is 50 mm, and the wall thickness is 5 mm. The yield and ultimate strengths of the rod material are 355 MPa and 470 MPa, respectively. The ultimate strength of the guide rod section is:

$$F_u = \frac{\pi}{4}[50^2 - 40^2](470) = 332\ kN\ (74.7\ kips)$$

The connecting components all have ultimate strength greater than this value. We have not included the details of those calculations here for brevity and proprietary reasons but we can provide them on request. The combined strength provided by the two upper steering guides is 149 kips.

4.7.4 Strap Strength

Spanset CS-50 safety straps attach the truck to the two car ends at the articulated connection. Each strap is used in the basket configuration; that is, the strap is wrapped around the component to which it is attached, providing twice the strength of the strap alone. The load rating for these straps in the basket configuration is 5,000 kg (11 kips). The straps have a safety factor of seven on strength, so that the ultimate strength of each strap in the basket configuration is 35,000 kg (77 kips).

The ultimate strength provided by the four straps attached to the supported end is: 4(77) = 308 kips.

4.7.5 Cable Strength

There are two steel cables attaching the truck to the supported car end. The cables are provided by Ingecables, S.A. and designated Steel Cable Slings Mod. T-C. The load rating for each is 1,517 kg (3.3 kips). The cable has a safety factor of six on strength, so that the ultimate strength of each cable is 9,100 kg (20 kips).

The two cables attached to the supported end provide the following combined ultimate strength: 2(20) = 40 kips.

4.7.6 Combined Longitudinal Truck Attachment Strength

The combined longitudinal ultimate strength provided by the steering guides, safety straps and cables is:

Combined strength = 149 + 308 + 40 = 497 kips.

If the rated strengths of the safety straps and cables are used instead of their ultimate strength, the combined longitudinal strength is:

Combined strength = 149 + 44 + 6.6 = 200 kips.

We confirmed that the strength of the steering guides, safety straps, and cables governs the strength in their load paths. We can provide these calculations on request.

4.7.7 Lateral Truck Attachment Strength

The components contributing to the lateral strength of the truck-to-carbody attachment include the steering guides, straps, cables, articulated connector and extended car sides. The truck would need to shear the articulated connector to separate laterally from the cars, as shown in

Figure 3.7. The minimum ultimate shear strength of the articulated connector (Section 4.2) is 123 kips.

The combined lateral strength is:

Combined strength = 123 + 308 + 40 = 471 kips.

4.7.8 Vertical Truck Attachment Strength

The required vertical strength according to §238.219 is 2g or 2(5,900) = 11,800 lb (11.8 kips). The combined ultimate strength of the four safety straps alone is 4(77) = 308 kips.

4.7.9 Attachment Strength According to the Alternative Requirements, §238.717

The alternative requirements require the following yield strengths:

- Vertical: 3g = 3(5.9) = 17.7 kips
- Lateral: 1g = 5.9 kips
- The truck must remain attached under the conditions of the collision scenario in §238.705

The strengths of the components attaching the truck to the car are greater than these values. The maximum (longitudinal) acceleration in the collision scenario (Section 4.1.2) is 21g. This equates to a longitudinal load of 124 kips (21x5,900), which is less than the 497 kip longitudinal truck-to-carbody strength.

5. DISCUSSION

The objective of our work was to evaluate the crashworthiness of the Talgo Series VI carbody relative to the current Code of Federal Regulations (CFR) Part 238 requirements and relative to conventional carbodies in the U.S. that meet those requirements.

We find that the Talgo Series VI carbody meets or exceeds the applicable CFR Part 238 structural crashworthiness requirements except for the one minor case of a longitudinal corner post load at 18 in. above the underframe at one side of the supported end, in which the strength is 70% of the CFR §238.213 requirement.

Occupant volume strength of carbodies by the CFR is satisfied in one of two ways:

1) §238.203: A buff (compressive) strength on the line of draft that is at least 800 kips (3560 kN.) This means that stresses in the car body for a load of 800 kips applied to the line of draft are less than the yield strength of the car body materials, or
2) §238.703: The car body must satisfy at least one of the following three criteria for loads applied on the collision load path:
    - i) A load of 800 kips without exceeding the yield strength of the car body materials
    - ii) A load of 1,000 kips without exceeding a plastic strain of 5% in the car body materials
    - iii) A load of 1,200 kips without exceeding the overall crippling (buckling) strength of the car body.

    The car body must have a minimum buff strength of 337 kips (1,500 kN.)

    For the 25 mph dynamic collision scenario defined in §238.705(b):
    - i) There shall be no more than 10 inches of longitudinal permanent deformation; or
    - ii) Global vehicle shortening shall not exceed 1 percent over any 15-foot length of occupied volume.

Our analysis shows that the Talgo Series VI carbody meets regulation §238.705 for occupant volume strength (Section 4.1). The cars have a calculated crippling strength of 1,280 kips (>1,200 kips). The maximum passenger car end deformation in the CFR §238.705 collision scenario is 7.5 in. (< 10 in.) for the most conservative case in which a Talgo Series VI train with eleven passenger cars and the non-crash-energy-management locomotive leading collides with the CFR §238.705 conventional train at 25 mph.The buff strength is 441 kips (>337 kips).

The required anticlimbing yield strength between cars (§238.205) is 100,000 lbs for both upward and downward movement of one coupled end relative to the adjacent end.

The Talgo Series VI carbody meets the CFR §238.205 anticlimbing strength requirement (Section 4.2). The Talgo Series VI anticlimbing strength is provided by the weight bearer bars and the articulated connection. We find from our calculations that for the controlling case (lowest strength) in which the suspended end moves upward relative to the supported end the two weight bearer bars alone provide a vertical strength (controlled by buckling) of 155 kips (>100 kips). The articulated connection adds substantial additional vertical strength. Our calculations show that the vertical yield strength of the articulated connection is 82 kips and the vertical ultimate strength is greater than 98 kips. Combining the parallel contributions of the weight bearer bars and the articulated connection results in a minimum vertical yield strength of 237 kips (>100 kips). Our calculations do not include the possible contribution of other components to the vertical strength, such as the steering guides and the truck retention cables and straps.

The CFR collision post requirements (§238.211) only apply to the ends of a semi-permanently coupled consist of articulated units when the articulated connections are capable of preventing disengagement and telescoping to the same extent as conventional designs. The Talgo Series VI trainsets are semi-permanently coupled articulated units with collision posts at the ends satisfying the CFR §238.211 requirements (see Section 4.3). The Talgo Series VI articulated connections have vertical strength exceeding the CFR requirement, and the trucks are positioned between cars to provide additional resistance against override.

The CFR corner post requirements (§238.213) are a 150 kip base ultimate shear strength, a 20 kip ultimate strength at the roof, and a 30 kip yield strength applied at 18 in. above the top of the underframe.

Our calculations show that the Talgo Series VI carbody meets the CFR §238.213 corner post requirements except for one case (Section 4.3). The minimum longitudinal and lateral base ultimate shear strength is 177 kips (> 150 kips), the minimum longitudinal and lateral roof ultimate strength is 21 kips (> 20 kips), and the minimum longitudinal and lateral yield strength at 18 in. above top of underframe is 49 kips (> 30 kips) for all except the supported end in the longitudinal direction on the side with the HVAC opening. The corner structure at this location has a strength of 21 kips. This one case of lower than CFR required strength had no bearing on the outcome of the 18 December 2017 derailment. The corner post requirement is for raking collisions; that is, collisions in which only the corner of the car is impacted.

Section §238.213 of the CFR requires stresses to be less than one-half the yield strength and one-half the critical buckling stress for a car resting on its side or roof.

Our finite element analyses show that the Talgo Series VI cars exceed the CFR §238.213 requirements for the car resting on its roof or on its side (Section 4.5). In both cases, the stresses are below one-half the yield and one-half the buckling stresses. (We actually doubled the weight of the car in our calculations and found the stresses to be below yield – no plastic deformation – and no occurrence of buckling.)

Section §238.217 places requirements on section moduli and sheathing (skin) thickness of the carbody side walls. We did not conduct separate calculations of the required side strength section moduli, but we reviewed the calculations conducted by Talgo and we find them to be correct (Sections 2.11 and 4.6) with respect to section moduli. We find the Talgo Series VI cars exceed the CFR §238.217 requirements: 21.4 cu in. (> 6.8 cu in.) for section moduli, and an equivalent sheathing of 3.66 (> 3.0) (Section 4.6).

Truck-to-carbody attachment strength by the CFR is satisfied in one of two ways:

- §238.219: Resist without failure (ultimate strength) the individually applied loads: 2g vertically on the mass of the truck; and 250,000 pounds in any horizontal direction on the truck, or

- §238.717: Resist without yielding the individually applied loads, 3g vertically downward; 1g laterally; 5g longitudinally provided the average longitudinal deceleration at the CG of the equipment during the impact does not exceed 5g; and the peak longitudinal deceleration of the truck during the impact does not exceed 10g for the dynamic collision scenario, or (instead of the 5g longitudinal requirement) the truck shall be shown to remain attached after a dynamic impact under the conditions in the collision scenario.

We find that the truck-to-carbody attachment strength of the Talgo Series VI cars meets both of these CFR §238.219 and §238.717 requirements (Section 4.6). For the section §238.219 requirements and for longitudinal loading, the two steering guides connecting the truck to the supported car end provide an ultimate strength of 149 kips, the four safety straps provide an ultimate strength of 308 kips, and the two cables provide an ultimate strength of 40 kips for a combined longitudinal strength of 497 kips (> 250 kips). For lateral loading, the four safety straps provide an ultimate strength of 308 kips, the two cables provide an ultimate strength of 40 kips, and the articulated connector provides an ultimate strength of 123 kips for a combined lateral ultimate strength of 471 kips (> 250 kips). The four safety straps alone provide an ultimate vertical strength of 308 kips (> 11.8 kips, 2g for the 5.9 kip truck weight.)

For the section §238.719 requirements and for, lateral loading, the four safety straps provide an ultimate strength of 308 kips (> 5.9 kips, 1g). For vertical loading the the four safety straps provide an ultimate strength of 308 kips (> 17.7 kips, 3g). The maximum acceleration in the dynamic collision scenario is 21g, giving a load of 124 kips, which is less than the longitudinal ultimate strength of the two steering guides for which the combined ultimate strength is 149 kips.

The Talgo Series VI cars meet or exceed the CFR structural crashworthiness requirements for all but the one minor corner post requirement. We also note that Tier I conventional trains in the U.S. are permitted to operate in the push-pull mode with a passenger-occupied cab car leading. The Talgo Series VI trains have two unoccupied vehicles at each end of the train, one a relatively heavy locomotive. Such a train configuration provides more safety to passengers than the cab car leading configuration.

Carbodies and trains like the Talgo Series VI carbodies and trains can be difficult to evaluate for individuals and groups who are mainly accustomed to the designs of conventional rail cars. Conventional cars in the U.S. are designed to longstanding requirements based on strength and are fabricated from steel. The international rail vehicle community now recognizes that energy absorption is far more relevant than strength in providing safety in collisions and derailments. Europe led the community in this regard, and nearly all passenger trains designed for operation in Europe and, increasingly, in other countries are based upon the crash energy management requirements of European standard EN15227. These products are predominantly aluminum. The CFR now (as of 2018) also incorporates CEM in its requirements via Part 238, Appendix G. These new rules will permit the growing use of passenger rail cars with higher levels of safety to passengers than those provided by conventional designs.

The inclusion in Appendix G of methods to evaluate occupant volume strength by analyzing a realistic collision load path is a recognition that, in all but the mildest collisions, load will not be applied to the carbody only through the coupler and the line of draft. The conventional coupler will either fracture or sawtooth in a severe collision, bringing the ends of the coupled cars together. We evaluated the Talgo Series VI carbody for such a realistic collision load path and found that the carbody meets the CFR requirements. The FRA’s grandfathering assessment relied upon the similar approach by ADL and the Volpe Center.

The conditions of the DuPont accident were unusually severe. The train derailed at a speed of 78 mph, and its cars rolled off a bridge onto the surroundings. There is no one in the rail vehicle engineering community who expects a train to provide absolute protection to passengers at such high speed and under such circumstances. The Volpe National Transportation Center has shown that the maximum train-to-train collision speed for which a Tier I train of conventional design can provide occupant volume protection is only 15 mph. They also showed that the crippling load of a conventional car is only 1,100 kips.

The NTSB had much discussion in their final report about truck separation from the Talgo cars. We find from our review of accidents in the U.S. several instances in which trucks separated from rail vehicles of conventional design in collisions and derailments. The issue of truck separation is not unique to the Talgo cars.

We determine that the Talgo VI design satisfies the truck-to-carbody attachment strength requirements of the CFR. This assessment is based in part upon achieving the ultimate strength of the safety straps. It is important that Talgo institute a maintenance program to ensure the safety straps do not degrade significantly.

6. CONCLUSIONS

We conclude with a high degree of engineering certainty:

- The Talgo VI cars meet or exceed the Code of Federal Regulation requirements for structural carbody strength.
- The Talgo VI cars exceed the CFR requirements for occupant volume strength and truck retention.
- The trucks of cars of conventional design become detached from the carbodies in high-speed accidents.
- The NTSB finding that Talgo VI cars pose unnecessary risk to railroad passenger safety when involved in a derailment or collision is incorrect.

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Appendix B

Subject: Re: DuPont Accident Report/ follow up from Talgo/ PLEASE REVIEW DRAFT EMAIL
Date: Wednesday, March 13, 2019 at 10:57:05 PM Eastern Daylight Time
From: [redacted] <[redacted]>
To: Hall Robert <[redacted]v>
CC: Turpin Ted <[redacted]>, Antonio Perez <[redacted]>, Joshua D. Coran <[redacted]>
Attachments: image001.png

Dear Mr. Hall;

I am following up on the email from Mr. Turpin below sharing your name as the person that would be providing contact information for Board Members. We are working on our Submittal Report but would like the opportunity to have a meeting to explain a serious issue for Talgo. Some of our customers are publicly raising concerns on Talgo S6 equipment based on assurances that the NTSB is going to blame the equipment for the accident or that it will make recommendations that will warrant removal of the Talgo equipment from service. This is affecting Talgo's business in the US , and potentially worldwide, when the NTSB report and recommendations have not even been issued, and when, in Talgo's expert opinion, other factors, not equipment related, bear responsibility. We truly did not anticipate this "campaign" to smear Talgo's safety record and reputation as a result of this accident, especially because our internal assessment is that it was caused by human error and we are confident of our equipment's behavior under such violation of speeds and forces. We fear this negative campaign is to meet this particular customer's objectives other than those we find fair or substantiated. Nevertheless, we are concerned we may be missing something important that we could be addressing with the NTSB. Mr. Turpin already pointed to our missing the submittal of Talgo's Report and we will be submitting that within the deadline provided.

We previously requested contact information on the Board Members because we don't know who is the appropriate person or persons to share said concerns with at the NTSB, but the serious implications force us to look for an appropriate audience. We ask for your guidance as we navigate through the NTSB protocols, which I assure you, it is our intent to respect.

We look forward to your response.

Respectfully,

Nora Friend
Talgo Inc.
V.P. Public Affairs & Business Development
Mobile: [redacted]

From: Turpin Ted <[redacted]>
Date: Thursday, February 28, 2019 at 1:46 PM
To: Nora Friend <[redacted]>
Cc: Hall Robert <[redacted]v>, Bucher David <[redacted]>, Sanzo Dana

<[redacted]>, Hiller Michael <[redacted]>
Subject: RE: DuPont Accident Report/ follow up from Talgo

Dear Ms. Friend,

On October 4, 2018, I sent an email to all party spokespersons that read:

"…if you intend on preparing a Party submission, please submit them by November 30, 2018. The Board is familiar with submissions that use the following format: Factual Information, Analysis, Findings, Probable Cause, and Proposed Recommendations. (Obviously, using the Board report format.)"

Part of that email contained NTSB draft factual reports. The Talgo representative provided factual corrections to the NTSB draft reports which we greatly appreciated. However, I never received a submission from Talgo which can contain analysis and findings. I am willing to extend the due date for a submission from Talgo but there is limited time. I would need this document before April 12, 2019, so that I can attach it to the package that staff provides to the Board.

Rob Hall, Director, Office of Railroad, Pipeline, and Hazardous Materials, will be emailing you in the near future to provide the contact information for the NTSB Board Members.

Sincerely,

Ted T. Turpin
[redacted]

[redacted]

From: Nora Friend <[redacted]>
Sent: Tuesday, February 26, 2019 4:22 PM
To: Turpin Ted <[redacted]>
Cc: Joshua Coran <[redacted]>; Allen, Benjamin <[redacted]>; Antonio Perez <[redacted]>; Jose Antonio Marcos <[redacted]>
Subject: Re: DuPont Accident Report/ follow up from Talgo

Thank you very much Mr. Turpin for this clarification.
We look forward to your respond on our request for a call with you and your Board member.

Respectfully,

Nora Friend
Talgo Inc.
V.P. Public Affairs & Business Development
Mobile: [redacted]

From: Turpin Ted <[redacted]>
Date: Tuesday, February 26, 2019 at 4:03 PM
To: Nora Friend <[redacted]>
Cc: Joshua Coran <[redacted]>, "Allen, Benjamin" [redacted]>, Antonio Perez <[redacted]>, Jose Antonio Marcos <[redacted]>
Subject: RE: DuPont Accident Report/ follow up from Talgo

Dear Ms. Friend,

We are not releasing the report today. We have a tentative schedule for the report to be presented publicly to our Board on May 21, 2019. If adopted that will be the release date of the report.

I will forward your interest in a conference call and respond later.

Sincerely,

Ted T. Turpin
[redacted]

[redacted]

From: Nora Friend <[redacted]>
Sent: Tuesday, February 26, 2019 3:31 PM
To: Turpin Ted <[redacted]>
Cc: Joshua Coran <[redacted]>; Allen, Benjamin [redacted]>; Antonio Perez <[redacted]>; Jose Antonio Marcos <[redacted]>
Subject: Re: DuPont Accident Report/ follow up from Talgo
Importance: High

Dear Mr. Turpin:

Can you please advise if the NTSB report is being released today and in which Board meeting will said report be presented? We received a message from Washington State saying they heard the report is being released today. If that is not the case, could you kindly give us an appointment time to call you? We would like to request a meeting in person or by phone with you and NTSB Board member to explain how our customers are speculating about possible NTSB findings and making critical decisions that have detrimental impact on Talgo's business in the US. WSDOT and newly appointed Amtrak Safety staff do not seem to understand the difference of the roles between NTSB and the FRA. The FRA has testified before the NTSB and knows Talgo equipment design but not everyone does. We respect your process fully and request any guidance you may be at liberty to provide in how we can address this issue prior to issuing your final report, if said report will take longer, given the renewal of our maintenance contract with the state of Washington is at stake in this time frame.

We appreciate your response to this email.

Respectfully yours,

Nora Friend
Vice President , Public Affairs & Business Development
Talgo, Inc
P.O. Box 9967
Washington, DC 20016
Mobile: [redacted]
Mail: [redacted]
Website: www.talgoamerica.com

From: Antonio Perez <[redacted]>
Date: Wednesday, December 12, 2018 at 7:43 PM
To: Turpin Ted <[redacted]>
Cc: Jose Antonio Marcos <[redacted]>, Joshua Coran <[redacted]>, "Allen, Benjamin" [redacted]>, Nora Friend <[redacted]>
Subject: Re: DuPont Accident Report

Mr. Turpin,

Thank you for your quick response and update. I appreciate and respect the NTSB's process.

Unfortunately Talgo's business is being affected for the timing of the report; I just learned today that Amtrak and Washington State Department of Transportation plan to delay the extension of a maintenance contract with Talgo until the NTSB report is issued. Please bear this in mind and, please, keep us updated on the progress of the work.

Thank you

Antonio Perez
President & CEO
Talgo Inc.
Cell: +[redacted]

From: Turpin Ted <[redacted]>
Date: Wednesday, December 12, 2018 at 12:32 PM
To: Antonio Perez <[redacted]>

Cc: Jose Antonio Marcos <[redacted]>, Joshua Coran <[redacted]>, "Allen, Benjamin" [redacted]>
Subject: RE: DuPont Accident Report

Mr. Perez,

The following is our current investigation status:

The DuPont railroad accident investigation is about two-thirds complete.

The NTSB investigators are studying several safety issues associated with the accident. One group of investigators has focused on the crashworthiness of the passenger cars. Another group is collecting and analyzing data regarding the decisions to start the train operations on Defiant Bypass. This effort includes the physical upgrades and the training and qualification of the operating crews. A specific area of interest is the system safety approach and the mitigation of identified potential hazards. Another group is examining the emergency response and injury causations.

On July 10 - 11, 2018, the NTSB conducted an investigative hearing about the railroad accident in DuPont, Washington: *Managing Safety on Passenger Railroads*. During the hearing, the NTSB heard testimony from multiple stakeholders. The information gathered during the hearing allowed investigators to gain additional information regarding the accident. Investigators are currently analyzing the factual information that was gathered.

The NTSB investigators plan to complete the analysis in the coming months. A final report will be delivered to the Board in a public board meeting in 2019.

The report will be all inclusive. The equipment will not have a separate report.

Sincerely,

Ted T. Turpin
[redacted]

[redacted]

From: Antonio Perez <[redacted]>
Sent: Wednesday, December 12, 2018 3:06 PM
To: Turpin Ted <[redacted]>
Cc: Jose Antonio Marcos <[redacted]>; Joshua Coran <[redacted]>
Subject: DuPont Accident Report

Dear Mr. Turpin,

Can you please advise when the final report will be available, at least as it refers to the equipment?

Some WSDOT's personnel not well informed and with little technical background have expressed concern about the equipment and we would like to show that the investigation concluded that the Talgo equipment behaved as designed. At this moment the delay in the release in the final report is damaging Talgo's reputation before WSDOT.

We understand that the report may also include some recommendations and we are interested in those. You may be aware that some are already being implemented.

Thank you

Antonio Perez
President & CEO
Talgo Inc.
Cell: +[redacted]

From: Turpin Ted <[redacted]>
Date: Monday, November 5, 2018 at 10:28 AM
To: Joshua Coran <[redacted]>
Cc: Antonio Perez <[redacted]>, Jose Antonio Marcos <[redacted]>
Subject: RE: DuPont Accident Technical Review Part 2
Resent-From: <[redacted]>

Mr. Coran,

Thank you for the review. I will forward this information to the Mechanical Group Chairman.

Ted T. Turpin
[redacted]

[redacted]

From: Joshua D. Coran <[redacted]>
Sent: Monday, November 5, 2018 1:21 PM
To: Turpin Ted <[redacted]>
Cc: Antonio Perez <[redacted]>; José Antonio Marcos <[redacted]>
Subject: RE: DuPont Accident Technical Review Part 2

Mr. Turpin,

Regarding the "DuPont Mechanical Group Factual Report" draft you sent to Antonio Perez on October 4, Talgo has two minor suggested clarifications:

Page 6 line 3 reads: "*The Talgo Series 6 trainsets are fully articulated trainsets with* **ten** *43' 1.32" long units and two 38' 8.17…"*
This description is accurate for the subject set, but each of the others have one more intermediate car. It might read either:

"Talgo 6 trainsets are fully articulated **with ten (in this case) or eleven (in that of the other four trainsets)** 43' 1.32" long units and…"

or…
"The **subject Talgo 6 trainset was** fully articulated, with ten 43' 1.32" long units and …"

Pg. 7 bullet 7 reads: "*Electrical systems including breakers,* **cab signal**, *and lights …*"
Cab signals were not then (and are not now) in use in the subject territory.

Josh

Joshua D. Coran
Director of Product Development and Compliance
Talgo, Inc.
Seattle

From: Antonio Perez [mailto:[redacted]]
Sent: Thursday, October 04, 2018 4:50 PM
To: Joshua D. Coran; José Antonio Marcos
Subject: Fwd: DuPont Accident Technical Review Part 2

Josh, Jose Antonio

I received the email below from Ted Turpin. He is asking that we review reports attached to his email. Can you do that, please?

Antonio Perez
President & CEO
Talgo Inc.
Cell: +[redacted]

Begin forwarded message:

From: "Turpin Ted" <[redacted]>
To: "Antonio Perez" <[redacted]>, "Carl W. Fields" <[redacted]>, "Herb Krohn" <[redacted]>, "Martin Young" <[redacted]>, "Pate" <[redacted]>, "Paul Aichholzer" <[redacted]>, "Scott Barrett" <[redacted]>, "Scott Palmer" <[redacted]>, "Shawn McCuaig" <[redacted]>, "[redacted]" <[redacted]>, "Turpin Ted" <[redacted]>, "Hunter, Kathy (UTC)" <[redacted]>
Subject: DuPont Accident Technical Review Part 2

Dear Party Spokespersons,

Earlier I asked you to review the group factual reports that were used for the Amtrak Investigative Hearing.

Attached are the additional factual reports from the DuPont, Washington accident on December 18, 2017.

I had expected additional addendums from the hearing but none were developed. I wanted to avoid having you do multiple reviews, so I waited until I was assured by the group chairman no other reports were forthcoming.

I apologize for the delay in sending these factual reports for review but I appreciate your input. Be aware that someone from your organization has reviewed the attached reports if they were assigned to the working group.

These reports will be used in developing the final NTSB accident report.

The enclosed draft reports are for official use only. Do not copy or release them or any portion of them to the public or the media. Please submit any corrections or comments to me by November 2, 2018. You may send your suggestions by hard copy to the address below or attached to an email. If I do not receive a response, I will assume that you have no comments to the attached reports.

Also, if you intend on preparing a Party submission, please submit them by November 30, 2018. The Board is familiar with submissions that use the following format: Factual Information, Analysis, Findings, Probable Cause, and Proposed Recommendations. (Obviously, using the Board report format.)

Please send a copy of your submissions to the other party spokespersons on this email. I will provide a copy of the submission to the Board Members.

Thank you,

Ted T. Turpin – NTSB
[redacted]

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Subject: Talgo Party Submission regarding December 18, 2017 Accident due April 12, 20019
Date: Thursday, April 11, 2019 at 7:03:39 PM Eastern Daylight Time
From: [redacted] <[redacted]>
To: Turpin Ted <[redacted]>
CC: Antonio Perez <[redacted]>, Joshua D. Coran <[redacted]>, José Antonio Marcos <[redacted]>, Hall Robert <[redacted]>
Priority: High
Attachments: image001.png

Dear Mr. Turpin,

Below please find a link where you can download Talgo's Party Submission relating to the accident on December 18, 2017. Thank you very much for the opportunity to submit this report. We took note the deadline is tomorrow, April 12, 20019 so we would appreciate you confirming receipt of the report by tomorrow. I am the person sending the report to you on behalf of Talgo Inc. as a formality but please note that if you have any questions, we would appreciate you copying all of us so we don't miss any important communication from you. Joshua Coran will follow up with a call tomorrow to make sure you can open and print the entire report. We noticed that, for some reason, one of our two printers was not printing some of the photos or arrows or text boxes pointing to the photos.

We look forward to assisting further, answering any question, and to have a final interview with you and your team if you find it necessary.

https://www.dropbox.com/[redacted]

Respectfully,

Nora Friend
Vice President , Public Affairs & Business Development
Talgo **Talgo, Inc**
Mobile: [redacted]
Mail: [redacted]
Website: www.talgoamerica.com

Subject: FW: NTSB Boardroom and Conference Center
Date: Thursday, May 2, 2019 at 3:23:15 PM Eastern Daylight Time
From: Joshua D. Coran <[redacted]>
To: Nora Friend - TalgoINC <[redacted]>

Nora,

This morning I called Mr. Hiller as you requested. t got his voice mail and left a message asking two questions:

1. Did he need any additional information from Talgo and
2. While we understand the Draft Report will be presented to the board at 1 PM on 5/21, we do not know where. I asked, "Can I assume 490 L'Enfant Plaza (NTSB HQ)?".

I just received the answers below.

I understand it will be possible to attend on line, but since we have to be in DC the following day unless I come to the meeting I'll be traveling and unable to connect on line. Thus I plan to attend in person. And will make arrangements accordingly.

JDC

From: Hiller Michael [mailto:[redacted]]
Sent: Thursday, May 02, 2019 12:02 PM
To: Joshua D. Coran
Subject: NTSB Boardroom and Conference Center

Hi Josh,

I got your VM. See the information below. I do not need any information at this time.

Stay Safe,

Mike H.

NTSB Boardroom and Conference Center

https://www.ntsb.gov/news/conferencecenter/pages/default.aspx may be unlawful.

Appendix C

Declaration of Joshua D. Coran Regarding NTSB Staff Statements
<u>During Investigation No. RRD18MR001</u>

I, Joshua D. Coran, hereby attest and swear that the following statements are true and accurate to the best of my knowledge:

1. I am Director of Product Development and Compliance at Talgo, Inc. ("Talgo"), located at 1000 Second Ave., Suite 1950, Seattle, WA 98104. I have served in this position for over 11 years and at all times relevant to the facts set forth in this Declaration.

2. From December 2017 to May 2019, I served as a party representative and one of the primary contacts for Talgo in National Transportation Safety Board ("NTSB") Investigation No. RRD18MR001, relating to the derailment of Amtrak passenger train 501 near DuPont, Washington, on December 18, 2017 ("the derailment"). Talgo was a party to the investigation due to its role as manufacturer of the passenger railcars at issue in the derailment.

3. Over the course of providing assistance on Investigation No. RRD18MR001, I interacted in person and via e-mail with the Investigator-in-Charge ("IIC"), Michael Hiller. As set forth below, I observed instances in which Mr. Hiller exhibited a predisposition against Talgo and aluminum-bodied railcars like those used in Talgo's Series VI trainset.

4. On March 5, 2018, four other Talgo employees and I arrived at a field on Joint Base Lewis-McCord, where the wrecked equipment from the derailment was being stored for inspection. My colleagues included another representative from Talgo, Inc., and three representatives from Talgo's Spain-based parent company, Patentes Talgo S.L. We began to inspect and photograph the twelve cars that comprised the "Mount Adams," the Talgo Series VI trainset involved in the derailment.

5. After approximately an hour, an individual identifying himself as Michael Hiller confronted my Talgo colleagues and me and demanded to know who we were and by what

authority we were at that location. Upon learning that we were there as Talgo representatives, Mr. Hiller insisted we give to him all photographs we had taken since arriving and then erase them from our cameras and phones. He also confiscated small pieces of rubber we had taken from one of the damaged cars. Mr. Hiller advised us that he could put us in jail and eject non-citizens from the US. He did not make the same demands or threats of representatives from other parties to the investigation who were taking photos and collecting evidence. The photographs were eventually returned several months later. I do not believe we ever received the rubber samples.

6. Another incident occurred at the public hearing at NTSB headquarters in Washington, DC, on May 21, 2019, at which the NSTB staff presented its findings and the board adopted them. During a break in the hearing, I engaged Mr. Hiller in conversation. In that conversation, he informed me that he "felt responsible" for the nine deaths that occurred at Fort Totten in Washington, DC, on June 22, 2009. That accident involved the collision of two WMATA (Washington Metro) heavy rail trains, both made up of aluminum-bodied cars. The collision produced a "telescope," in which the structure of one car fails, allowing the other to enter into its interior. Mr. Hiller said his sense of responsibility stemmed from the fact that he was the WMATA equipment engineer at the time.

7. Mr. Hiller informed me that, as a result of the Fort Totten accident, he took it upon himself to correct the situation by eliminating aluminum cars that in his view were not sufficiently "crashworthy." He claimed that he was instrumental in obtaining the funding for the new fleet of stainless steel 7000 series WMATA cars, which have recently replaced the 1000 series aluminum cars.

So stated this 28th day of October, 2019.

[redacted]________________

Joshua D. Coran
Director of Product Development and Compliance
Talgo, Inc.

Appendix D

U.S. Department
of Transportation

**Federal Railroad
Administration**

Administrator

1200 New Jersey Avenue, SE
Washington, DC 20590

The Honorable Robert L. Sumwalt III
Chairman
National Transportation Safety Board
490 L'Enfant Plaza SW
Washington, DC 20594

SEP 2 7 2019

Dear Chairman Sumwalt:

This letter is the Federal Railroad Administration's (FRA) response to the National Transportation Safety Board's (NTSB) Safety Recommendations R-19-008 through -015 and reiterations of R-16-32, R-16-35, R-16-36, and R-17-17. The NTSB issued and reiterated these safety recommendations, respectively, after its investigation of the December 18, 2017, derailment of National Railroad Passenger Corporation (Amtrak) train 501 in DuPont, Washington.

Based on FRA's investigation, FRA maintains the primary cause of the Amtrak 501 derailment was the failure of the engineer and the conductor to comply with Amtrak's operating rules. Specifically, the engineer failed to prioritize attention and situational awareness to properly call out speeds and identify the wayside signals and signs. FRA also maintains that improper crewmember training was a contributing accident cause, as FRA's investigation found training for the assigned crewmembers of Amtrak 501 did not comply with Federal regulations. With these factors in mind, please find below FRA's specific responses to each safety recommendation.

Safety Recommendation R-19-008:

> *Study the efficacy of how signs used in other modes of transportation may be effectively used in the railroad industry.*

In compliance with the Fixing America's Surface Transportation (FAST) Act,[1] Amtrak had posted adequate, highly visible signage approaching the area where the derailment occurred. FRA verified the presence of this signage, alongside the NTSB, on the approach to the accident curve as part of the investigation. The highly visible signage was in place two miles from the speed restriction. As a result, FRA believes that studying the efficacy of how signs are used in other modes of transportation will be of limited to no-benefit in the rail context. Through FRA's

[1] *See* Fixing America's Surface Transportation Act, Pub. L. No. 114-94, § 11406, 129 Stat. 1312, 1683 (Dec. 4, 2015).

audit processes as well as engagement with the railroad industry, FRA believes that most Class I railroads already have posted signs for permanent speed restrictions. FRA continues to review signage as part of its auditing process. FRA is preparing internal guidance to its inspectors when performing audits, and this internal guidance will include a review of signage.

FRA believes that implementation of positive train control (PTC) will effectively mitigate the risks of overspeed derailments such as the Amtrak 501 accident. Accordingly, FRA will complete its internal guidance but will not take any further action in response to Safety Recommendation R-19-008. FRA requests that the NTSB close Safety Recommendation R-19-008.

Safety Recommendation R-19-009:

> *Require railroads to periodically review and update their speed limit action plans to reflect any operational or territorial operating changes requiring additional safety mitigations and to continually monitor the effectiveness of their speed limit action plan mitigations.*

Safety Recommendation R-19-010:

> *Require railroads to apply their existing speed limit action plan criteria for overspeed risk mitigation to all current and future projects in the planning, design, and construction phases, including projects where operations are provided under contract.*

In response to the Amtrak 188 derailment, FRA issued Emergency Order No. 31[2] to require Amtrak to take specific actions to ensure the safe operation of passenger trains on the Northeast Corridor, including modifications to its Automatic Train Control system design, prior to full implementation of its PTC system. FRA subsequently published Safety Advisory 2015-03 in June 2015 to reinforce the importance of compliance with Federal regulations and applicable railroad rules governing passenger train speed limits.[3] These actions were bolstered by the enactment of the FAST Act in December 2015, which required intercity and commuter passenger railroads to submit Speed Limit Action Plans to FRA for review and approval. Under the FAST Act, these plans were to identify, within 90 days, all main track locations where there was a reduction of speed of more than 20 miles per hour and describe appropriate actions to enable warning and enforcement of the maximum authorized speed.

FRA received, reviewed, and approved all the plans as required by the FAST Act. Notably, Amtrak's FRA-approved Speed Limit Action Plan (Plan) indicated Amtrak would require communication between the locomotive engineer and another qualified crewmember when its trains approached speed restrictions falling under the FAST Act requirements on non-Amtrak owned routes and that Amtrak would specify this requirement in general orders tailored for specific routes. Amtrak, however, failed to comply with its own Plan and the general order

[2] 80 Fed. Reg. 30534 (May 28, 2015).
[3] 80 Fed. Reg. 33585 (June 12, 2015).

applicable to the Lakewood Subdivision where the accident occurred did not include such instructions. Although FRA does not have the authority under the FAST Act to require updates to the statutorily mandated Speed Limit Action Plans and add criteria for future projects, railroads, including Amtrak, have developed and implemented plans with such requirements and FRA will continue to periodically audit railroads' compliance with their operating rules consistent with those plans.

As noted above, FRA is preparing internal guidance to its inspectors when performing audits, and this internal guidance includes a review of Speed Limit Action Plans. FRA will complete its internal guidance, but believes the implementation of PTC will effectively address this issue. Accordingly, FRA will not take any further action on Recommendations R-19-009 and R-19-010 once the guidance is disseminated. FRA requests that the NTSB close the recommendations.

Safety Recommendation R-19-011:

> *Prohibit the operation of passenger trains on new, refurbished, or updated territories unless positive train control is implemented.*

Consistent with the NTSB's Safety Recommendation R-19-011, FRA's existing regulations explicitly prohibit any new intercity or commuter rail passenger service from commencing after December 31, 2020, unless and until an FRA-certified PTC system "has been installed and made operative." *See* 49 CFR § 236.1005(b)(6).

As background, as the Rail Safety Improvement Act of 2008 (RSIA) first mandated, Class I railroads and entities providing regularly scheduled intercity or commuter rail passenger transportation must fully implement PTC systems on main lines subject to the statutory mandate.[4] The Positive Train Control Enforcement and Implementation Act of 2015 (PTCEI Act) extended the original statutory deadline for railroads' full implementation of FRA-certified and interoperable PTC systems from December 31, 2015, to at least December 31, 2018.[5] In addition, the PTCEI Act required FRA to approve any railroad's alternative schedule and sequence—with a deadline for full implementation beyond December 31, 2018, but not later than December 31, 2020—if the railroad demonstrated it met the six statutory criteria necessary to qualify for an alternative schedule by law.[6]

Four host railroads fully implemented FRA-certified and interoperable PTC systems on their required main lines by December 31, 2018, and the other 37 applicable railroads qualified for, and obtained FRA's approval of, an alternative schedule and sequence. Railroads continue to make significant progress toward full implementation of PTC systems on the required main lines. As of March 31, 2019, PTC systems were in operation on almost 48,050 of the nearly 58,000 route miles subject to the statutory mandate. Also, railroads were conducting advanced

---

[4] *See* Rail Safety Improvement Act of 2008, Pub. L. No. 110-432, § 104(a), 122 Stat. 4848 (Oct. 16, 2008).
[5] *See* The Positive Train Control Enforcement and Implementation Act of 2015, Pub. L. No. 114-73, 129 Stat. 568, 576–82 (Oct. 29, 2015), codified as amended at 49 U.S.C. § 20157.
[6] 49 U.S.C. § 20157(a)(3)(C) (using the term "shall").

field testing, known as revenue service demonstration, on an additional 341 route miles as of March 31, 2019.[7]

As noted above, beginning January 1, 2021, all regularly scheduled intercity or commuter rail passenger transportation must be governed by a PTC system on the main lines subject to the statutory mandate, except as otherwise permitted under the PTCEI Act.[8] The RSIA generally defined the term "main line," for purposes of PTC system implementation, as "a segment or route of railroad tracks over which 5,000,000 or more gross tons of railroad traffic is transported annually."[9] However, it also established an exception to that general definition and mandated that the Department of Transportation define the term "main line," by regulation, specifically for purposes of intercity or commuter rail passenger transportation routes over which limited or no freight railroad operations occur.[10] Following extensive input from the industry and the Railroad Safety Advisory Committee (RSAC), on January 15, 2010, FRA issued its first final PTC rule, which defines "main line" for purposes of intercity or commuter rail passenger transportation, and provides certain narrow exceptions, which FRA approves on a case-by-case basis, only if a railroad submits a formal request demonstrating it meets the operational and other criteria for such an exception.[11]

Any request for a main line track exception requires an analysis of the operating risks, which the railroad must mitigate through certain speed restrictions, limitations on the frequency of daily operations, and the amount of freight traffic, and/or other safety measures.[12] FRA may also require a railroad to conduct a collision hazard analysis to identify hazards and to undertake specific risk mitigations.[13] Eliminating these narrow exceptions would require a rulemaking, and based on FRA's findings during prior rulemakings, there would be little to no known safety benefits to offset the significant costs of requiring a PTC system on track segments that host limited daily passenger rail service and otherwise ensure safety through other mandatory measures. Under FRA's regulations, however, FRA reserves the right to periodically review main line track exceptions and rescind them if it finds noncompliance with any applicable requirement.[14]

Since FRA's first final PTC rule was issued in 2010, Amtrak and other railroads have requested exceptions covering only 3.8 percent of the main lines otherwise subject to the statutory

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[7] Railroads' Quarterly PTC Progress Reports for Quarter 2 of 2019 were due July 31, 2019. *See* Form FRA F 6180.165, Office of Management and Budget Control No. 2130-0553. In August 2019, FRA expects to publish updated infographics on its website (https://www.fra.dot.gov/ptc), summarizing railroads' progress toward fully implementing PTC systems as of June 30, 2019.

[8] The PTCEI Act recognizes that certain PTC system failures (e.g., initialization failures, cut outs, and malfunctions) may occur until approximately December 31, 2021, as further specified in the statute, but a railroad must both operate at an equivalent or greater level of safety than the level of safety achieved immediately prior to the use or implementation of the PTC system and comply with certain safety measures during any PTC system failures. *See* 49 U.S.C. § 20157(j).

[9] 49 U.S.C. § 20157(i)(4) (formerly § 20157(i)(2)).

[10] 49 U.S.C. § 20157(i)(4)(B) (formerly § 20157(i)(2)(B)).

[11] *See, e.g.*, 75 Fed. Reg. 2598, 2657–60 (Jan. 15, 2010), as codified at 49 CFR §§ 236.1003 and 236.1019.

[12] *See* 49 CFR § 236.1019(b)–(d).

[13] 49 CFR § 236.1019(d).

[14] 49 CFR § 236.1019(d).

mandate. Despite any earlier requests for exceptions, railroads may still implement PTC systems on these track segments. For example, Amtrak has recently committed to implementing a PTC system on its Post Road Branch in New York—possibly in addition to other lines for which Amtrak previously sought, and FRA approved, an exception.

FRA remains committed to assisting the industry as it continues to fully implement PTC systems on the nearly 58,000 route miles subject to the mandate, in addition to other lines where railroads are voluntarily implementing PTC systems. FRA also notes that a PTC system has been implemented on the main line where the Amtrak 501 derailment occurred.

Accordingly, FRA will take no further action in response to Safety Recommendation R-19-011 and FRA requests that the NTSB close the recommendation, as FRA's existing regulations, including 49 CFR § 236.1005(b)(6) regarding new passenger rail service, address the recommendation.

Safety Recommendation R-19-012:

> *Remove the grandfathering provision within Title 49 Code of Federal Regulations 238.206(d), and require all railcars comply with the applicable current safety standards.*

The grandfathering provision under the Passenger Equipment Safety Standards,[15] 49 CFR Part 238, concerns compliance with requirements for Static End Strength, as prescribed in 49 CFR § 238.203. Section 238.203 is based on the long-standing practice of constructing passenger cars to possess a minimum static end strength of 800,000 pounds on the line of draft without permanent deformation of the body structure. When the Passenger Equipment Safety Standards were issued in 1999, this structural requirement was made applicable to passenger equipment existing at the time—the only such structural requirement not otherwise phased in as new equipment was ordered and delivered. Consequently, FRA included the grandfathering provision as a means for FRA to approve the safe use under defined conditions of then-existing passenger equipment designed to other criteria for static end strength.

The five Talgo Series 6 trainsets (a total of 67 individual cars) were designed to meet Union of International Railways (UIC) standards with respect to compressive strength, with a 200-metric ton (441,000-pound) underframe at the floor (buff strength). When Amtrak petitioned FRA to provide approval for their use in its Cascades service, there were three areas that FRA identified as requiring modifications to bring the equipment up to an alternate compliance level. As a result, the Talgo rail cars were structurally enhanced by:

a. Increasing the strength of the weight-bearing bars (two per car) and their related supports to each car's structure to withstand a minimum vertical load of 100,000 pounds, applied either up or down.

b. Applying safety cables between the cars and bogies (trucks) to resist a minimum total longitudinal force of 77,162-pounds (35,000 kg). This load was determined by Talgo to

[15] 64 Fed. Reg. 25540 (May 12, 1999).

be the limit of the structural design of the ends of the cars. Also, the cables were designed to mitigate the separation of the car bodies and bogies, thus the separation of the cars from one another.

c. Applying a safety cable around the top of each suspension column, affixed to the upper structure of the cars to resist the application of a nominal 250,000-pound load at the center of gravity of the bogie.

Further, as a condition of FRA's approval, FRA required Amtrak/Talgo to inspect the draft sill/collision post structure at the ends of each "end service car" not less than every 368 days, to determine that the structure/car body is free from fatigue cracks and loose attachment fasteners. FRA also attached various other conditions to provide for the safe use of the equipment, and made clear FRA's approval was route-specific.

In the Amtrak 501 derailment, the end structure supporting the Talgo Series 6 equipment showed no evidence of premature failure and proved to perform exceptionally well for such a high-energy event. FRA's observations from the accident site revealed that there was no loss of occupant volume due to end-frame compression. Because the grandfathering provision concerns end-frame compression strength and this strength for the Talgo Series 6 trainsets was not a factor in the Amtrak 501 derailment, FRA does not believe it appropriate to remove the grandfathering provision on the basis of this accident, or any other basis. The grandfathering provision and FRA approvals under the provision are narrowly tailored and conditioned on specific facts to provide for the safety of passenger equipment in a defined operating environment. Accordingly, FRA requests that the NTSB close Safety Recommendation R-19-012.

Safety Recommendation R-19-013:

> *Use your authority and compel all commuter and passenger railroads to meet the requirements outlined in Title 49 Code of Federal Regulations Part 238 without delay, such that in the event of a loss of power, adequate emergency lighting is available to allow passengers, crew members, and first responders to see and orient themselves, identify obstacles, safely move throughout the rail car, and evacuate safely.*

Commuter and intercity passenger railroads already comply with various requirements to have and ensure the proper functioning of emergency systems to facilitate egress and rescue access in the event of an emergency. These requirements were strengthened as part of FRA's Passenger Train Emergency Systems II (PTES II) rulemaking,[16] and incorporate American Public Transportation Association standards for emergency systems.

Most passenger cars currently used in the United States have emergency lighting that is powered by batteries integrated in the cars with the specific lighting fixtures they support. Being an older series, the Talgo Series 6 cars have emergency lighting that is powered by batteries that connect to the cars' light fixtures by cables. When cables were severed during the Amtrak 501 derailment, so too was the emergency lighting from its power source.

[16] 78 Fed. Reg. 71785 (Nov. 29, 2013).

FRA's requirements for passenger train emergency systems are complementary, and include requirements for intercity passenger trains like the Talgo Series 6 to have auxiliary portable lighting in addition to fixed emergency lighting as part of the railroad's emergency preparedness plan.[17] FRA has also sought to phase-in requirements for existing passenger cars where practical, and enforces the requirements for emergency lighting systems applicable to existing passenger cars through the PTES II rulemaking. FRA is in discussion with Amtrak on installing a backup battery source specific to individual emergency lighting fixtures on trainsets that still rely on a battery and cable system. Accordingly, FRA will take no further action in response to Safety Recommendation R-19-013 and FRA requests that the NTSB close the recommendation.

Safety Recommendation R-19-014:

> *Reevaluate existing seat securement mechanisms and their susceptibility to inadvertent rotation, to identify a means to prevent the failure of these devices to maintain seat securement.*

Rotating seat locking mechanisms are, and have always been, considered subject to FRA's requirements for passenger equipment seat and interior fixture strength attachment under 49 CFR § 238.233. There is no evidence (from either NTSB's investigation or FRA's investigation) to suggest that the current 8g longitudinal, 4g vertical, and 4g lateral resistance requirements are inadequate when properly applied. FRA has worked with Amtrak to ensure that its crews follow procedures to ensure the proper securement of rotating seats. Accordingly, FRA will take no further action in response to Safety Recommendation R-19-014 and FRA requests that the NTSB close the recommendation.

Safety Recommendation R-19-015:

> *Conduct research into the effectiveness of occupant protection through compartmentalization for passengers whose size (including children) is not within the current range of anthropomorphic passenger sizes in Federal Railroad Administration standards.*

As part of FRA's passenger equipment safety research program, seat/occupant protection experiments were incorporated into full-scale rail car and train-to-train impact tests. Anthropomorphic Test Devices (ATDs) were set up in various seating arrangements, and placed in various locations within the rail passenger car and locomotive compartments. Each experiment included different sized ATDs (5th-percentile female, and 50th- and 95th-percentile male ATDs) to obtain a spectrum of data that accounted for extremes in size and mass both from sensors in the ATDs and the seats. The results of these experiments did not demonstrate that changes are required to FRA's regulations as the NTSB recommends.

The main objective with a compartmentalization approach to occupant protection is to contain passengers between rows of seats, so that under conditions such as in the Amtrak 501 derailment

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[17] *See* 49 CFR § 239.101(a)(6)(iii).

they do not travel longer distances, which are associated with increasing secondary impact velocities, before they strike another part of the car's interior. Smaller, lighter passengers are less likely to deform the seat ahead of them and be thrust over the top of the seatback than larger, heavier passengers. FRA has determined that compartmentalization is as effective for children as it is for the 5th-percentile female. Compartmentalization is also part of a larger occupant protection strategy that includes recessed or flush-mounted interior fittings and mitigating the consequences of impacting any interior surface. Accordingly, FRA will take no further action in response to Safety Recommendation R-19-015 and FRA requests that the NTSB close the recommendation.

Safety Recommendation R-16-32:

> *Require railroads to install devices and develop procedures that will help crewmembers identify their current location and display their upcoming route in territories where positive train control will not be implemented.*

In a letter sent March 28, 2019, FRA explained to the NTSB that FRA would take no further action on this recommendation because: (1) the technology does not exist; (2) there are few to no known safety benefits to offset its significant cost; and (3) a regulation requiring railroads to install the technology would be redundant with existing rules in that crew members, as part of their certification, are required to demonstrate knowledge of the physical characteristics of the route over which they are operating and existing speed limit signs required by the FAST Act provide an additional layer of redundancy. In its letter to FRA dated June 21, 2019, the NTSB reiterated this recommendation, noting that moving map displays using global positioning systems are commonly used on electronic devices and that Amtrak was developing such a system for use on territory subject to a PTC Mainline Track Exclusion. FRA is monitoring Amtrak's initiative to develop and implement this technology and FRA will share the results of Amtrak's initiative with industry as appropriate.

However, as noted in its March 28, 2019, letter, FRA believes requiring installation of this type of technology on territories where PTC is not statutorily required would result in little safety benefit and frustrate railroads' voluntary implementation of PTC systems on routes not legally mandated, as well as railroads' voluntary implementation of other technologies such as Trip Optimizer. Accordingly, FRA will take no further action in response to Safety Recommendation R-16-32 and once again requests the NTSB close the recommendation.

Safety Recommendation R-16-35:

> *Conduct research to evaluate the causes of passenger injuries in passenger railcar derailments and overturns and evaluate potential methods for mitigating those injuries, such as installing seat belts in railcars and securing potential projectiles.*

In a letter sent August 23, 2017, FRA informed the NTSB that after extensive evaluation of available mitigation methods for occupant protection, FRA had concluded that focusing efforts on passenger containment, interior attachment integrity, and ensuring that passengers survive secondary impacts are the most effective methods of preventing and mitigating passenger injuries in derailments and overturns. FRA believes that these efforts address the recommendation, and therefore requested a closed-acceptable designation by the NTSB. In its letter to FRA dated June 21, 2019, the NTSB reiterated this recommendation and reclassified it as "Open—Unacceptable Response." However, FRA's position on this recommendation has not changed and the agency will take no further action. FRA once again requests that the NTSB close Safety Recommendation R-16-35.

Safety Recommendation R-16-36:

> *When the research specified in Safety Recommendation R-16-35 identifies safety improvements, use the findings to develop occupant protection standards for passenger railcars to mitigate passenger injuries likely to occur during derailments and overturns.*

In the same letter sent August 23, 2017, regarding Safety Recommendation R-16-35, FRA informed the NTSB that its RSAC process remains the primary mechanism for FRA to discuss and develop Federal regulations related to passenger equipment safety issues. Specifically, FRA stated that in 2009, RSAC's Passenger Safety Working Group created the Engineering Task Force to further examine issues and research topics concerning passenger equipment safety, including occupant protection. These efforts subsequently led FRA to amend its Passenger Equipment Safety Standards in November 2018 using a performance-based approach to adopt new and modified requirements governing the construction of conventional- and high-speed passenger rail equipment.[18] FRA will continue to use RSAC to address the regulatory needs of passenger railcar safety and continues to believe its actions have addressed this recommendation, notwithstanding the NTSB's letter to FRA dated June 21, 2019, in which the NTSB reiterated this recommendation and reclassified it as "Open—Unacceptable Response." FRA therefore will take no further action in response to Safety Recommendation R-16-36 and requests that the NTSB close the recommendation.

Safety Recommendation R-17-17:

> *Enact Title 49 Code of Federal Regulations Part 270, "System Safety Program," without further delay.*

The NTSB reiterated this recommendation in its letter to FRA dated June 21, 2019. On August 12, 2016, FRA published a final rule requiring commuter and intercity passenger railroads to develop and implement a system safety program (SSP) to improve the safety of their operations.[19] The SSP rule is part of FRA's efforts to continuously improve rail safety and to satisfy the statutory mandate in the RSIA.[20] FRA subsequently stayed the SSP final rule to address petitions for reconsideration filed by certain labor organizations and State and local

[18] 83 Fed. Reg. 59182 (Nov. 21, 2018).
[19] *See* 81 Fed. Reg. 53850 (Aug. 12, 2016).
[20] *See* 49 U.S.C. §§ 20156, 20118, and 20119.

transportation departments and authorities.[21] On June 12, 2019, FRA issued a proposed rule to respond to the petitions.[22] FRA is working diligently to issue the SSP final rule.

As the SSP rule was built on existing industry practice, a systematic, risk-based safety management program is an essential safety tool for any railroad operation—regardless of whether such a program is required by Federal regulation. FRA continues to offer its technical assistance and support to any railroad or entity who chooses to continue with the implementation or maintenance of voluntary safety programs. FRA will continue to support the industry in these efforts as the rulemaking progresses through the regulatory process.

I appreciate your interest in these important safety issues. If FRA can provide further information or assistance, please contact Mr. Karl Alexy, Associate Administrator for Railroad Safety and Chief Safety Officer, at [redacted] or [redacted].

Sincerely,

[redacted]

Ronald L. Batory
Administrator

[21] *See* 83 Fed. Reg. 63106 (Dec. 7, 2018).
[22] *See* 84 Fed. Reg. 27215 (June 12, 2019).

Appendix E

Talgo

Antonio Perez
President and CEO, Talgo, Inc.
1000 Second Ave., Suite 1950
Seattle, WA 98104

June 3, 2019

The Honorable Robert L. Sumwalt
Chairman, National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

Re: Talgo, Inc. US notice of intent to file Petition for Reconsideration
NTSB Investigation No. RRD18MR001

Dear Chairman Sumwalt,

I write on behalf of Talgo, Inc. to provide notice of Talgo's intent to file a Petition for Reconsideration under 49 C.F.R. § 845.32 regarding certain findings, safety recommendations, and the probable cause of the subject accident. During the investigation, Talgo was not afforded an adequate opportunity to supplement, clarify, or refute evidence that, unbeknownst to Talgo, would be a focal point of the NTSB's final conclusions. This deprived the NTSB of a complete picture of the equipment and mechanics at issue, and has resulted in erroneous factual findings, safety recommendations, and probable cause determinations set forth in the Accident Report synopsis.

As an initial matter, we, too, have an abiding interest in the safety of our trainsets and the passenger rail industry as a whole. Regrettably, we believe the NTSB's report is founded on an insufficient factual basis and erroneous analysis regarding the rail equipment involved that are actually counterproductive to safety in the industry, as the report unfairly tarnishes a product that is both useful in meeting demand while serving as a safe product in doing so. Talgo has been designing and manufacturing safe and reliable equipment for over 75 years, and we stand behind our equipment's crashworthiness and safety record worldwide.

Over the course of the investigation, and culminating with the NTSB's adoption and publication of the Accident Report synopsis, Talgo was limited in the opportunity to provide full and complete factual information and engineering evidence to the investigation. As a result, NTSB staff and Board Members did not have available or did not properly interpret all information relevant to the crashworthiness of a design that has significant differences from the conventional rail equipment historically operated in the U.S. This is especially important as the NTSB acknowledged from the very beginning of the investigation that its rail specialists were unfamiliar with the technology and behavior of the Talgo train sets under normal operating conditions, let alone in high energy accidents.

- Talgo was prohibited, and in fact threatened with arrest, when it attempted to take photographs of its derailed train cars at the Joint Base Lewis-McChord to aid in its own safety assessment, while other parties to the investigation were allowed to do so. The NTSB's investigators' insistence on exclusivity and control early in the investigation deprived us of an early opportunity to present our informed analysis to the Board. The NTSB's unwillingness to collaborate undermined both the fact-finding process and the thorough documentation of evidence.

- Although the NTSB contacted multiple stakeholders to testify or otherwise participate at the July 10-11, 2018 investigative hearing, Talgo was not a designated party for the hearing or invited to testify. Talgo's participation in the hearing would have provided important evidence and understanding of the behavior of Talgo equipment to the NTSB staff and Board Members, which should have been considered in reaching their conclusions and recommendations.

- Talgo made no less than four written and several oral requests to meet in person with NTSB staff or Board Members to answer questions, provide additional information and evidence where needed, and discuss possible NTSB findings. Unlike similar requests from the other parties, Talgo's requests were rebuffed.

- There is no indication that Talgo's April 12, 2019 Party Submission was considered by investigators or the NTSB Board Members in connection with the Accident Report. The NTSB's findings and recommendations as stated in the synopsis do not reflect and are starkly inconsistent with the extensive technical information provided by Talgo in this document, and in several other submissions made by Talgo the previous year. In fact, Talgo is concerned that its party submission did not even make it into the hands of the NTSB Board Members. Talgo also alerted NTSB that mistakes were made in the course of the investigation, but they appear to have been ignored.

- The factual findings and probable cause determination turn on the NTSB's conclusion that certain fatalities and injuries were worsened and possibly caused by the design of the Talgo trainsets, even though the trainsets met industry standards when designed and manufactured and still do today. Talgo will point to evidence in the record and also provide evidence not reviewed by the agency that demonstrate these conclusions are erroneous.

We understand that the final Accident Report will be published in the next several weeks. We request the opportunity to provide additional factual information and clarification about the evidence in the record before the Accident Report becomes final, in order that the NTSB provides the public with the most accurate conclusions and safety recommendations possible in its official report. In any case, we respectfully request that the NTSB publish this letter on the public docket promptly to reflect Talgo's belief that the factual record for this investigation is incomplete, that the findings and conclusions reached by the NTSB are unfounded, and of Talgo's intent to file a Petition for Reconsideration

Best regards,

[redacted]

Antonio Perez
President and CEO, Talgo, Inc.

cc: Mike Hiller
Railroad Accident Investigator, National Transportation Safety Board

Kathleen Silbaugh
General Counsel, National Transportation Safety Board

Gary Halbert
Holland & Knight LLP